TRANSACTIONS

OF THE

Illinois State Academy of Science

TWELFTH ANNUAL MEETING

Jacksonville, Illinois, March 21 and 22, 1919

VOLUME XII

1919

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EDITED BY
J. L. PRICER AND A. R. CROOK
1920

OHIO STATE
UNIVERSITY

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OFFICERS AND COMMITTEES FOR 1919-1920

President, HENRY B. WARD, University of Illinois, Urbana.
Vice-President, GEO. D. FULLER, University of Chicago, Chicago.
Secretary, J. L. PRICER, State Normal University, Normal.
Treasurer, W. G. WATERMAN, Northwestern University, Evanston.

The Council

THE PRESIDENT, PAST PRESIDENT, VICE PRESIDENT, LIBRARIAN, SECRETARY AND TREASURER

Publication Committee

THE PRESIDENT, the SECRETARY, and H. J. VAN CLEAVE

Committee on Membership

ELIOT BLACKWILDER, University of Illinois, Chairman.
CLARENCE BONNELL, Harrisburg Township High School.
J. H. WHITTEN, Chicago Normal College.
H. E. GRIFFITH, Knox College.
STUART WELLER, University of Chicago.

Committee on Secondary School Science Education

C. H. SMITH, Chicago, Chairman.
F. D. BARBER, Normal.
ISABEL S. SMITH, Jacksonville.

Committee on Affiliation of High School Science Clubs with The Academy.

J. L. PRICER, Normal, Chairman.
W. G. WATERMAN, Evanston.
H. S. PEPOON, Chicago.

Committee on an Ecological Survey

S. A. FORBES, University of Illinois, Chairman.
H. C. COWLES, University of Chicago.
T. L. HANKINSON, State Normal School, Charleston.
V. E. SHELFORD, University of Illinois.
H. S. PEPOON, Lake View High School, Chicago.
GEO. D. FULLER, University of Chicago.
A. G. VESTAL, State Normal School, Charleston.
FRANK C. GATES, Carthage College.

Committee on Conservation of Wild Life

R. E. WAGER, State Normal School, DeKalb, Chairman.
H. C. COWLES, University of Chicago.
H. S. PEPOON, Lake View High School, Chicago.
FRANK SMITH, University of Illinois.

PAST OFFICERS OF THE ACADEMY

1908

President, T. C. CHAMBERLIN, University of Chicago.
Vice-President, HENRY CREW, Northwestern University.
Secretary, A. R. CROOK, State Museum of Natural History.
Treasurer, J. C. HESSLER, James Millikin University.

1909

President, S. A. FORBES, University of Illinois.
Vice-President, JOHN M. COULTER, University of Chicago.
Secretary, A. R. CROOK, State Museum of Natural History.
Treasurer, J. C. HESSLER, James Millikin University.

1910

President, JOHN M. COULTER, University of Chicago.
Vice-President, R. O. GRAHAM, Illinois Wesleyan University.
Secretary, A. R. CROOK, State Museum of Natural History.
Treasurer, J. C. HESSLER, James Millikin University.

1911

President, W. A. NOYES, University of Illinois.
Vice-President, J. C. UDDEN, University of Texas.
Secretary, FRANK C. BAKER, Chicago Academy of Science.
Treasurer, J. C. HESSLER, James Millikin University.

1912

President, HENRY CREW, Northwestern University.
Vice-President, A. R. CROOK, State Museum of Natural History.
Secretary, OTIS W. CALDWELL, University of Chicago.
Treasurer, J. C. HESSLER, James Millikin University.

1913

President, FRANK W. DEWOLF, State Geological Survey.
Vice-President, H. S. PEPOON, Lake View High School, Chicago.
Secretary, E. N. TRANSEAU, Eastern Illinois Normal School.
Treasurer, J. C. HESSLER, James Millikin University.

1914

President, A. R. CROOK, State Museum, Springfield.
Vice-President, U. S. GRANT, Northwestern University, Evanston.
Secretary, EDGAR N. TRANSEAU, Eastern State Normal School, Charleston.
Treasurer, J. C. HESSLER, James Millikin University.

1915

President, U. S. GRANT, Northwestern University, Evanston.
Vice-President, E. W. WASHBURN, University of Illinois, Urbana.
Secretary, A. R. CROOK, State Museum, Springfield.
Treasurer, H. S. PEPOON, Lake View High School, Chicago.

1916

President, WILLIAM TRELEASE, University of Illinois, Urbana.
Vice-President, H. E. GRIFFITH, Knox College, Galesburg.
Secretary, J. L. PRICER, State Normal University, Normal.
Treasurer, H. S. PEPOON, Lake View High School, Chicago.
Librarian, A. R. CROOK, State Museum, Springfield.

1917

President, J. C. HESSLER, James Millikin University, Decatur.
Vice-President, JAMES H. FERRIS, Joliet.
Secretary, J. L. PRICER, State Normal University, Normal.
Treasurer, T. L. HANKINSON, State Normal School, Charleston.
Librarian, A. R. CROOK, State Museum, Springfield.

1918

President, R. D. SALISBURY, University of Chicago, Chicago.
Vice-President, ISABEL S. SMITH, Illinois College, Jacksonville.
Secretary, J. L. PRICER, State Normal University, Normal.
Treasurer, T. L. HANKINSON, State Normal School, Charleston.
Librarian, A. R. CROOK, State Museum, Springfield.

MINUTES OF THE TWELFTH ANNUAL MEETING

Illinois College, Jacksonville, March 21–22, 1919

The twelfth annual meeting of the Illinois State Academy of Science was called to order in the Chapel building of Illinois College, Jacksonville, at 2:00 P. M. Friday, March 21, 1919, by Dean R. D. Salisbury, President of the Academy.

After a very cordial address of welcome by Dean F. S. Hayden of Illinois College, and a response by President Salisbury, the following business was transacted.

The minutes of the 1918 meeting, held at Joliet, were read by the Secretary and approved as read. Next, the Secretary read his annual report. On motion, the Academy voted unanimously to approve the action of the Council in accepting the terms and conditions of affiliation between the Academy and the Division of State Museum of the Department of Registration and Education of the State Government submitted to the Academy by Dr. F. W. Shepardson, director of said department. On motion, however, the Secretary was instructed to endeavor to secure the consent of Dr. Shepardson to a slight change in the wording in sections one and two of the plan of affiliation. Dr. Shepardson gladly agreed to the suggested changes and the revised form of the terms of affiliation is included in the Secretary's report printed later in this volume.

Following this action, the following proposed amendments to the Constitution and By-laws were adopted by unanimous vote: First, to amend Article V of the Constitution, (1) by adding the word "Librarian" after the word "Treasurer" and (2) by adding the following paragraph at

the end of the present article. The Board of State Museum Advisors, created under the provisions of Civil Administrative Code of Illinois, shall be consulted by the officers of the Academy, in all matters which concern the general policy of the Academy in its relations to the Division of State Museum.

Second, to amend the By-Laws, (1) by substituting the word "Librarian" for the word "Secretary" in Article VI, and (2) by adding the following paragraph to Article VIII: Papers presented by authors *in absentia*, shall be read by title only, unless the Academy votes to hear them.

On motion, the Academy voted unanimously to express its willingness to become affiliated with the American Association for the Advancement of Science, on what were at the time the tentative terms for such affiliations proposed by the said association. These terms are included in the Secretary's report. Since that time, however, the Committee of the American Association, on affiliations, has decided on terms for such affiliations, which are sufficiently different from the terms voted on by the Academy to make a reconsideration of the matter as a whole, by the Academy necessary.

On motion, the Academy voted to have a committee of three appointed by the President to formulate plans and conditions, and to secure the affiliation of science clubs in high schools and colleges and other local science organizations with the Academy, according to a plan suggested in the Secretary's report. J. L. Pricer, H. S. Pepoon, and W. G. Waterman were appointed as this committee.

On motion, it was voted that the President appoint a permanent committee of three on Secondary Education in Science, to make annual reports to the Academy as to the conditions of secondary school science, and to devise and suggest means of cooperation between the Academy and this important interest. C. H. Smith, F. D. Barber, and Isabel S. Smith were appointed on this committee.

Next, the Treasurer made his annual report and on motion it was referred to a committee on auditing. On

motion, it was voted that the officers offer for sale to libraries or to individuals 150 full sets of published transactions at $5.00 per set, net.

On motion of Dr. Noyes, the Academy voted, with but two dissenting votes to endorse the movement for two-year courses in fundamental science for secondary schools, as suggested in a paper read by J. L. Pricer, and printed in this volume. Dr. Noyes supported this motion by making the point that such a plan was in harmony with the movement for a synthesis of the sciences such as botany, advocated by Dr. Coulter in his symposium paper.

Next, the President announced the following committees: Committee on nominations: De Wolf, Cowles, and Pricer. Committee on resolutions; Pepoon, Forbes, and Millspaugh. Committee on auditing: Van Cleave, Fuller and Hessler.

Following the business session, several papers of general interest were presented, and then followed reports on the forestry survey which had been conducted during the previous year by members of the Committee on Ecological Survey, at the suggestion and under the direction of Dr. S. A. Forbes, chairman of the committee.

At six thirty o'clock, the members of the Academy present, and a large number of Jacksonville citizens, enjoyed together a delightful dinner prepared by the ladies of the First Christian Church, after which Dr. Josephine Milligan of Jacksonville, who had recently returned from a year's service under the Red Cross in France, delivered an interesting lecture on her work among the civilians of France.

At eight thirty o'clock, the largest audience that has attended an Academy meeting in several years assembled in the Chapel of the Illinois Woman's College to hear President Salisbury's illustrated lecture on Porto Rico.

The session of Saturday forenoon consisted of a symposium on the general topic: "Science and Reconstruction."

At noon, Saturday, the visiting members of the Academy were given a delightful complimentary luncheon by the faculty of Illinois College, at Academy Hall of the college.

At two o'clock P. M., a brief business meeting was held to hear the reports of committees on auditing, on resolutions, and on nomination of officers. The officers elected for the ensuing year are as follows: President, Dr. Henry B. Ward, University of Illinois; Vice President, Dr. Geo. D. Fuller, University of Chicago; Secretary, J. L. Pricer, State Normal University; Treasurer, Dr. W. G. Waterman, Northwestern University. Membership Committee, Dr. Eliot Blackwilder, chairman, University of Illinois; Clarence Bonnell, Harrisburg Township High School; Dr. J. H. Whitten, Chicago Normal College; H. E. Griffith, Knox College; Dr. Stuart Weller, University of Chicago. Member of Committee on Publications, Dr. H. J. Van Cleave, University of Illinois.

After this business session, and the presentation of a few general papers, the meeting was divided into two sections for the presentation of the remaining papers on the program, and adjournment occurred about four thirty P. M.

J. L. PRICER, Secretary.

REPORTS OF OFFICERS AND COMMITTEES

SECRETARY'S REPORT
JACKSONVILLE, MARCH 21, 1919

No meeting of the Council has been held during the year. All business of the Academy, including the arrangements for this meeting, has been carried on by correspondence. This variation from the usual practise was suggested by the urgent necessity of reducing the expenses of the Academy to the minimum.

In accordance with the motion adopted at the Joliet meeting giving the Council power to perfect an affiliation of the Academy with the Division of State Museum, of the Department of Registration and Education, of the State Government, the secretary took the matter up with Dr. Francis W. Shepardson, Director of the aforesaid department, early last spring. After much correspondence and one personal conference with Dr. Shepardson, he finally submitted a very simple plan of affiliation under date of Dec. 7, 1918, as set forth in the following letter and plan:

December 7, 1918.

MR. J. L. PRICER,
Illinois State Normal University,
Normal, Illinois.
Dear MR. PRICER:

After conference with Mr. Crook on the general plan of affiliation, I am sending you a revised statement which is simpler than the one I gave you under date of December 5.

Should this general plan be approved by you, I think there will be no difficulty. I feel that in view of the state appropriation, the Chief of the Museum ought to be a member of the Executive Committee, as in a sort of way, the protector of the interests of the State. The oversight by the State Museum Board, in my judgment would be extremely general since their feeling would naturally be entirely friendly to the Academy. But as the Code provides that this Board shall have general oversight of the Museum, it is put into the arrangement as a matter of courtesy.

I have already arranged for the inclusion in the budget of an item of a thousand dollars per annum for the Academy, this being contingent upon the closing of the arrangement on your part.

Yours very truly,

F. W. SHEPARDSON, Director.

A PLAN OF AFFILIATION BETWEEN THE ILLINOIS STATE ACADEMY OF SCIENCE AND THE STATE MUSEUM

1. The Illinois State Academy of Science, by action at its annual meeting, declares itself to be an affiliated division of the State Museum Division of the Department of Registration and Education of the State of Illinois.

2. The Illinois State Academy of Science agrees to seek the Council and advice of the Board of State Museum Advisors, created under the provisions of the Civil Administrative Code of Illinois in all matters which concern the general relations between the two divisions.

3. The State Museum at Springfield shall be the depository for the books and other property of the Academy. The Chief of the State Museum division of the Department of Registration and Education shall be librarian and custodian, and, during the continuance of this arrangement, shall be ex-officio a member of the Executive Committee of the Academy.

4. With the exception of the addition of the Chief of the State Museum to the Executive Committee, the constitution of the Illinois Academy of Science, and its present methods of procedure, need not be changed under this arrangement.

5. The Department of Registration and Education, on its part, will seek through the State Museum division, an annual appropriation from the legislature toward the expenses of the printing of reports and other publications of the Academy and for postage, express and stationery connected therewith.

6. This affiliation arrangement may be terminated at any time by either party but only upon a year's notice in advance.

Upon receiving this statement of the plan, the Secretary immediately submitted it by correspondence to the different members of the Council and all voted in favor of its adoption. A brief and simple amendment to the constitution of the Academy covering the essential changes involved in the plan is to be voted on at this meeting.

On March 4th, the appropriation committees of the two houses of the legislature, held a hearing on the request of the Academy for an appropriation of $2,000.00 for the biennium. Dr. Crook, Dr. Hessler, Professor Hankinson, and I were present. We were given a very courteous hearing, and feel that we have every reason to expect that the appropriation will be made. Thus, this affiliation with a branch of the State government, seems to be an altogether proper and a happy union.

We have now presented to us, an opportunity for another equally desirable affiliation. We are invited to become affiliated with the American Association for the Advancement of Science.

The revised constitution of the American Association, presented at the Baltimore meeting for adoption at the St. Louis meeting next December, contains an article providing for the affiliation of such local Academies as ours. The American Association has appointed a committee of three to consider and recommend a detailed plan for such affiliations. The members of this committee are: Dr. Catell, Dr. Coulter and Dr. Ward, the latter two, members of our Academy. This committee has had appointed, in each of the several states in the central west, which support state academies, and in Missouri where there is the city academy of St. Louis, a committee of five, to cooperate with the committee of the American Association in working out the details of such affiliations. This committee for Illinois consists of Messrs. Coulter, Ward, Crew, Hessler, and Pricer. One meeting of our state committee has been held with but two members—Coulter and Pricer—present, but with some letters from others.

The Committee of the American Association has pretty definitely agreed on the essentials of the plan which they shall recommend for the affiliation of state academies, and I may state these with the understanding that they are as yet tentative, but nevertheless quite certain to prevail.

The main feaures of such tentative terms are as follows:

1. The local academy will be permitted to have two classes of members, namely: first, those who are merely members of the local organization, and who pay only the local dues, which is a dollar a year in the case of the Illinois Academy; second, members, who are also members of the American Association, who pay annual dues of five dollars, and receive the weekly journal, Science.

2. The local academy will collect all dues from members of both classes, including initiation fees, then it will send to the American Association four dollars for each affiliated member, keeping all the rest for local use, except, of course, the initiation fee to the American Association.

3. The local organization will be given representation on the council of the American Association in proportion to the number of affiliated members it has.

It seems to me that in accepting such a liberal plan of affiliation, we would have everything to gain and nothing to lose. By this plan, no member of the local organization will be compelled to join the American Association, and yet one may do so at a saving of a dollar a year of annual dues over what is possible at present. On the other hand, there are within the State many subscribers to Science and members of the American Association who are not members of the Illinois Academy. Any of these might become members of the local Academy, with no additional expense except the one dollar initiation fee.

It is obvious that the American Association is seeking no financial advantage or any other kind of advantage for itself as an organization, in this plan. It is simply endeavoring to mobilize and organize the scientific forces of the nation so that they may co-operate more effectively in rendering their natural services to society.

One thing that should make such an affiliation peculiarly desirable for our organization just now, is the fact that the next two meetings of the American Association are to be in St. Louis and Chicago respectively. During these two years, we should be able to greatly increase our membership if a suitable campaign is carried on.

While we are in the affiliating business, it seems to me that we might carry the thing just a little farther. I will give a concrete illustration of what I have in mind. We have at the Normal University at Normal, a science club, consisting of the members of the science faculty, and not more than forty student members, who are elected to membership on the recommendation of faculty members. For the past three years, this club has sent a student delegate to the meetings of the State Academy, paying his or her expenses. One such delegate is here today. The next meeting of our local club will be devoted to a report on the Academy meeting, in which this student delegate will be the principal speaker. Now, there are science clubs like this in many high schools, and they could be organized in many other high schools. There are small scientific organizations among the grown people in some of the larger cities of the State. Why should not all such organizations be affiliated in some way with the State Academy. I believe that we should have a permanent committee of three on affiliations, whose duty should be, first to work out a plan for such affiliations and, second, to seek to bring about as many such affiliations as possible.

Education in science is so vital to the general welfare of every other phase of science, that it seems to me that every member of the Academy should have some interest in the problems of science education in the secondary schools. Therefore, I believe that the Academy should have a permanent committee of three on science education in the secondary schools. It should be the function of this committee to make annual reports to the Academy on the status of secondary school science, and on occasions to call on the Academy for cooperation and help in the solution of certain problems.

J. L. PRICER, Secretary.

Report of the Treasurer

March 21, 1919.

RECEIPTS

February 18, 1918, Balance on hand	$ 222.93
March 21, 1919, Dues to date	573.00
March 21, 1919, Life Membership fees	302.00
March 21, 1919, Donations	238.00
Total receipts	$1,335.93

EXPENDITURES

Printing Vols. IX and X	$1,204.25
Expenses of officers	88.00
Postage, stationery, etc	26.40
Balance on hand, March 21, 1919	17.22
Total expenditures	$1,335.93

T. L. Hankinson, Treasurer.

Addresses

ADDRESSES

*THE BOTANICAL OPPORTUNITY

JOHN M. COULTER, UNIVERSITY OF CHICAGO

In connection with the period of reconstruction, there has come to the science of botany a great opportunity, and botanists must rise to the occasion. It is a critical time for our science, for we may lapse into our former state and become submerged by more aggressive sciences that will rise to the occasion. You realize that at the present moment the scientific study of plants is more fully recognized as a great public service than ever before in the history of botany. The recent pressure for food, and for a wide range of plant materials and products has been met in the main, not by so-called practical men, but by trained botanists. Not only the practical government service, but also many industries are calling for botanists with fundamental training, realizing as never before that progress is based upon research.

A response to this opportunity for public service does not mean *less* science, but *more* science; but it ties up our science so closely to the human interest that it will be in large demand. We are on the rising tide of the greatest demand for trained botanists we have ever known, and it is our task to see to it that the tide does not ebb and leave the profession stranded. If we respond, the opportunities for research will be greater than ever before, as they always are when a science is recognized as of large service.

My purpose is to indicate certain things we must stress in ourselves and in our students if we are to rise to the opportunity.

1. *The synthetic view.*—As we all know, botany has developed many fields of research, and as these fields have multiplied, botanists have become more and more segregated into groups; in fact, in the history of botany we have just been passing through the phase of the *analysis* of our subject.

The development of research increased this narrowing process, for it deals with special regions of a general field. For example, in research there came to be as many kinds

* Complete paper published in Science, N. S. Vol. XLIX, page 363.

of morphologists as there are great groups of plants, and so for other fields. This analysis was inevitable and desirable, for it developed technique, the essential equipment for research.

Now, however, the movement is in the other direction. We are passing from the analysis of our subject to its *synthesis,* and it is this synthesis that is being called for by the new botanical opportunity. The synthetic view recognizes, not the rigidity of separate fields, but the cooperation of all fields. Every phase of botany must be focused upon our important problems, for we recognize that every important problem is synthetic. Our superficial separate problems that we have been cultivating have introduced us to the fact that nature is a great synthesis, and must be attacked synthetically. In the days ahead, the botanist who remains narrow will be stranded.

2. *The practical outlook.*—The new opportunity demands this; in fact, it was this that created the new opportunity. This means that we are to see to it that botany is recognized as the greatest field for universal service. Medicine holds that position now in public estimation, simply because it ministers to the unfortunate, but they are in the minority. Botanical research underlies an essential ministry to all. Disarticulation of botany from its practical applications has been most unfortunate, and must not be continued. For example, to segregate botany and agriculture as two distinct fields is to damage both; a mistake that our recent experience has emphasized. The result has been that botany has not contributed to agricultural practice as it should; and agricultural practice has not called upon botany as it should.

This is very far from meaning that every investigation should have an obvious practical application. Research must be absolutely free, stimulated only by its own interest in advancing knowledge, but the importance of fundamental knowledge in solving practical problems should be emphasized at every opportunity.

3. *Cooperation in Research.*—Our isolated, more or less competitive investigations have resulted in a certain amount of progress; but it has been very slow compared with what cooperation would have secured. The important

problems today are either too complex for the training of any one investigator, or they call for too many data for one investigator to secure, at least in a reasonable time.

This suggests what is probably the most serious obstacle to any general adoption of the cooperative method. We have worked so long in our isolated way in a kind of monastic seclusion, that we have come to regard our problems as personal property, and feel a sort of resentment if any other investigator ventures within our territory. This means that, perhaps unconsciously, we are more concerned with our own personal credit than with the solution of the problem. If our old method has developed this attitude of mind among investigators, it is high time to change it and to realize that research is to advance knowledge, and is not for self-glorification. What the science wants, and what the world wants, is *results,* as quickly and accurately as possible. If we cannot be large enough to put truth above ourselves, the outlook for botany is discouraging.

The spirit of competition between individuals is depressing enough, but when it extends to competition between research establishments it is worse. This spirit of aloofness is the more emphasized between institutions that deal primarily with practical questions and those that deal primarily with fundamental research.

In conclusion, if I may venture a prophecy, it would be that if in response to the great opportunity that has come to us, we shall pledge ourselves to be synthetic rather than narrow in our point of view, to emphasize the possible practical connections of botanical problems, and to submerge our personal and institutional temperaments in a spirit of general cooperation to secure results, botany will come to be recognized as a great national asset, and research will enter upon a new era.

Symposium on Science and Reconstruction

SYMPOSIUM ON SCIENCE AND RECONSTRUCTION

THE EFFECTS OF THE WAR ON SCIENCE AND THE OPPORTUNITIES AND RESPONSIBILITIES OF SCIENCE UNDER THE NEW ORDER OF THINGS

ZOOLOGY

HENRY B. WARD, URBANA, ILLINOIS

In a sense the effects of the war on the science of zoology are not very different from those it exerted upon other branches of science. In many particulars identical results have followed. The expenses of maintaining work have increased with astonishing rapidity. The number of workers available has been cut down so greatly that many lines of activity have been necessarily suspended if not actually abandoned, and it is hard to see how the pre-war organization can be re-established. In any event it will require considerable increase in endowments and appropriations to finance the work that was under way when the conflict broke on the world. In case new activities are necessitated by the war, as appears to many to be urgently needed, then an even greater increase in financial support will be required. In certain ways the monetary aspect impresses itself most forcibly on those who are in charge of work in institutions for teaching and research.

I do not attach any special significance to the fact that in some such institutions the staff has been depleted in its higher ranks in that men have been called to assume duties in connection with some branch of warfare that demanded the services of an expert zoologist. This has been true, of course, but at the close of the war many such men will return to their old positions and if some have been attracted away from university and college life to what seemed to them to be larger opportunities in other fields, this loss can be made good by advancing those of subordinate grade who have demonstrated their fitness in the meanwhile. The period of pressure during continuance of the war was exceptionally well calculated to test the fitness of men for larger responsibilities and to prepare them rapidly for the assumption of such duties. While in a narrow sense they are lost to our science, yet in the broader influence they are enabled to exert zoology will profit.

To one who examines carefully the entire field both in teaching and in research, the most serious element in the situation seems to be the failure of the stream of recruits to the profession at its sources. Those undergraduates who were in position to be attracted by the opportunities of graduate work in zoology have had their attention diverted to other lines by influences so powerful that in the majority of cases they will not turn back. Those graduate students who were in preparation for the duties of teaching and research have largely been called upon to take up work in other lines and many of them have become so thoroughly intrenched in other fields that they will hesitate to assume the loss incident to the transfer to another line of activity, even if that be the field in which they were interested of old. With the coming of the war the undergraduate body was greatly reduced in numbers, but the enrollment of the graduate schools was affected far more seriously. In zoology at least the enrollment in various institutions fell off from 20 to 90 per cent and those who were left were by no means sufficient to meet even the limited demand for the services of graduate students in this field during war times. The numbers now available will be entirely inadequate to supply the needs for the instructional staff that is sure to be demanded in the period immediately after the war.

Furthermore, the stipends of such positions have always been low, and in comparison with the greatly reduced purchasing power of money, which does not seem likely to be increased in the near future, these positions will not only be much less attractive but are likely to prove impossible for such as previously sought to secure them. While ten years ago or less the stipends furnished were adequate to provide, though scantily, for the actual expenses of the graduate student, now they must be supplemented very considerably to meet even the most modest requirements of such workers. In the face of opportunities on every hand to secure occupations in other lines with generous stipends, the practical disadvantage will deter many from going back to graduate study. They will give up, accordingly, their plans for an academic career and leave the sources of professional assistants seriously depleted. When it is considered that under the requirements for the Ph.D. degree, which in the majority of good institutions has been a condition for entrance to the faculty in

zoology, a student is obligated to spend at least seven years in training beyond the completion of the high-school course and to reach an age of 25 or 26 years before becoming in any degree self-supporting. All must realize that the present salaries paid to members of our teaching staffs are so inadequate as to deter men from entering upon the career unless they are in possession of private means and are moved by an overwhelming desire to devote themselves to this field of work. Once that the supply of trained workers is reduced, it will require considerable time to restore it to proper dimensions because of the time element involved.

During the war period zoology has not experienced the same stimulating effects that have influenced the development of chemistry and physics, for its relation to practical aspects of warfare are not so direct and so striking. It would be wrong, however, to pass over the indirect influence which has been exerted upon it by the general stimulation of war conditions, and the need for efficient workers and dependable work. It is not too much to say that every worker in scientific fields has been impressed with the necessity of pushing his investigations as rapidly as possible and securing the maximum results with the time and energy at his disposal. The drive of the war, which has influenced greatly every phase of human activity, has been to a considerable extent free from the serious effects of pressure under other conditions by reason of the exacting demand for precision and accuracy, and the rigid test to which all the results have been put before they were utilized in a practical way. This increased intensity of effort and emphasis upon the quality of results achieved has, I think, been evident in every field and constitutes a helpful influence for the development of zoological research in the future as well as in the immediate present. The standards necessarily set in war work will serve a good purpose for the development of science in the next period of its activity.

The universal emphasis upon the conservation of natural resources, including human life, and upon the application of discoveries to the elimination of every possible waste and the development of every obtainable advantage in the struggle, has exercised a specific and important influence upon zoology, even though biological work had a less immediate bearing upon the situation than did the work in

some other fields of science. It was what are sometimes denominated as the practical or applied aspects of this science that have been particularly emphasized and developed. Specific examples of this may be taken from various parts of the field.

Thus, the need of conserving and even increasing as largely as possible the food supplies of the nation led to research inquiry into those influences which tend to reduce the numbers of food animals and thus deplete the food supply. A study of the national bill-of-fare, as shown by the statistics of commerce in food articles, indicated at once that the population of the central area of the United States consumed on the average a very much smaller supply of fish as food than was utilized by most other countries in the world. Further inquiry into the situation indicated the presence of numbers of different kinds of fish that were utilized only exceptionally, if at all, as human food. Experimental data furnish in various ways the evidence that among these types of fish which were neglected or scorned were various sorts that possessed qualities of flesh and flavor such as to make them admirable articles of food. It appeared in the examination of the situation that prejudices of one type or another interfered with the use of these fish, and a campaign of publicity which utilized zoological as well as psychological influences resulted in largely increased consumption of types of fish that were previously utilized as well as created a demand for species that had never been included in the human bill-of-fare.

Improvements in methods of catching, preserving, distributing, marketing, and preparing various fish foods were included in this campaign, and the demand for better knowledge of the species of fish, of their distribution and habits made demands upon zoological investigators familiar with this group that could be met in part only by examination and critique of existing data and demanded as well renewed study of the fish and their distribution, food, environment and habits.

It is evident that the same general problem demanded a reconsideration and improvement of the methods which were in vogue for maintaining and increasing the number of fish. As a result hatchery methods, the plans for obtaining supplies of fish eggs and for planting them under favorable conditions, the possibility of finding unutilized

environments for breeding food fishes, and a host of other similar questions came up for attention among those who were previously working on such problems and also forced themselves upon the notice of others who had not before been concerned in the study of applied ichthyology.

As this field of investigation was being brought more fully to the attention of biologists, one factor which had previously been emphasized without having won effective notice attracted general attention as of distinct importance. Pollution of our streams by domestic and industrial wastes had often been pointed out as a source of damage to the fish life and thus, indirectly, to the general public. So long as food was abundant and the loss could be replaced readily by food supplies drawn from other sources, the significance of the draft upon the nation by reason of the pollution of its waters did not seem to demand particular attention. Under the changed circumstances the loss became significant and the situation was still further modified in an unfavorable way by another factor. As necessary adjuncts of war activities, numerous plants for the manufacture of chemicals had sprung into existence. Utilizing processes marked by their efficiency in terms of time rather than by their ultimate effectiveness, they were paying no attention to the by-products that were produced in connection with the main processes, and were dumping into streams enormous quantities of chemical substances that exerted conspicuous and serious effects on the life of the waters. Attention was thus still more forcibly directed to the need of controlling waste products and avoiding the damage produced by them. The opportunity afforded for scientific study was great, but few were free to take up the problems intensively and the desired results are evidently to be looked for in the future rather than immediately. The urgency of war production was in many minds a sufficient answer to the complaint of loss resulting from the situation, and while some record has been made of the losses incurred both in the industries themselves through the wastage of valuable by-products and to the public in general through the destruction of areas adapted to the propagation and growth of food fishes as well as in various other ways that are indirect, though very real, it is only now that conditions are really favorable for investigating the ways in which the loss can be prevented and the pollution cleaned up.

Perhaps the most conspicious field in which the war influenced the development of zoological science was that dealing with the relations of animals to disease. It became of paramount importance to preserve the health of the soldier. The conditions under which he worked had been in previous wars characterized by a striking increase in the amount of disease, even to the extent of incapacitating armies and defeating well-planned military campaigns. Within rather recent times the investigations of the relations of animals to disease had resulted in disclosing an essential connection between certain types of animal life and specific maladies. It was known that some of the diseases which had threatened the existence of the soldier in previous wars depended absolutely upon specific types of animals for transmission. In other cases where the demonstration had not been made so directly, there was reason to believe that similar relations existed. In the study of the relations of animals to disease, which, was inaugurated and pressed with intensity in connection with the health service of all fighting forces discoveries of striking magnitude were made.

Because of their evident and immediate relation to the welfare of man these discoveries are sure to exert a powerful influence upon the trend of scientific research. They have aroused widespread interest among workers in other fields and have given a significance to work of this type which assures it a permanent place among the research activities in zoology.

THE PROBLEM OF FOOD PRODUCTION SINCE THE ARMISTICE

EUGENE DAVENPORT, UNIVERSITY OF ILLINOIS

The farmer is greatly perplexed as to what his policy should be in regard to food production for the coming season. One year ago notices were posted everywhere that food would win the war. Whether or not it was true that food would actually win the war, we know now that the lack of foc would have lost the war; that is to say, we nearly lost it in the early summer because of the shortage of food. The world was scoured for wheat and for every substitute that could save wheat. A stimulating price was fixed to increase its production, and people began to talk about famine, not without reason, for unquestionably thousands have died during the war for lack of food.

Now, however, we are literally smothered in wheat. We have more meat and dairy products in storage and in prospect than ever before in our history. It looks as if the war is over, and the question with the farmer now is, "Has our stress for food production passed?" The only adequate means for answering this question is to learn what we can of the actual conditions across the water.

In the early autumn the Secretary of Agriculture dispatched a commission to Europe to study the agricultural situation in England, France, and Italy; and since that time Mr. Hoover himself has been abroad endeavoring to learn still more accurately what the food conditions are, not only with the Allies but more especially in the central and eastern districts.

The Secretary's commission reported substantially that despite the distressed conditions, the cattle population of England had actually increased since the war began; both sheep and pigs had declined in numbers but not alarmingly. In France all live stock had unquestionably been reduced, and the same was true in Italy; but even so, the reduction had been made with care and a very large amount of breeding stock was preserved and widely scattered. Belgium, of course, and northern France were entirely stripped of live stock and of all forms of food.

Quite aside from these considerations, it must be remembered that, except for the Percheron horse, England is the only belligerent country which uses our breeds of live stock. We shall not expect, therefore, any considerable call for breeding stock, because in general each country, except Belgium, will restore its own herds. But every one of these countries will require large shipments of animal and dairy products and wheat, in order to preserve its own herds as far as possible for breeding purposes.

The best study which the commission was able to make led to the report that the Allies would need from us this year some twenty million tons of food as against the eleven millions of the preceding year. It must be remembered that this estimate was made before the signing of the armistice and that now, with shipping somewhat released, a wider market is open, especially for wheat.

Little is yet known definitely about the condition of Germany and Austria-Hungary. The systematic thoroughness with which they stole everything which could be eaten, taken in connection with the fact that this was an industrial war in which the Central Powers set out to destroy their neighbors, leads us to conclude that Germany at least is fairly well provided for. Such was her own assertion, although there are indications now that all is not well in Germany, especially in respect to food.

Conditions in Russia are practically unknown except that in general she has ceased producing and millions of people are starving in the very districts which were once exporting wheat.

How then may we sum up the outstanding conditions as a whole? First of all, western Europe will probably not need any very great numbers of breeding animals from this side, but will require extensive shipments of animal products, especially fats, certainly for the current year and probably for at least another.

As to the middle and eastern sections, everything depends upon the stability of government. The need for food in those districts is unquestionable, but without stable governments and the required credit they cannot secure it unless we are generous enough to give it to them, and there are those who are inclined to say that Germany has

sent to the bottom of the ocean some millions of tons of perfectly good wheat and meat. It is there. Let them go and get it! Perfectly just though this might be, it is neither foresighted nor diplomatic, and unquestionably the Peace Conference is wise in doing everything it can to establish governments in the defeated sections with the greatest speed and the greatest certainty possible. If this cannot be done, and if the Russians are to go on butchering each other indefinitely, then the actual call for food, beyond that of our Allies, will not be large.

It is fair to assume, however, that arrangements will be made for feeding Armenia and for relieving distress in all allied or neutral countries so far as credit can be arranged. Even this will call for an enormous amount of food and if in addition the Central Powers and Russia should succeed in establishing stable governments in the next few weeks, the call upon the United States for food will be enormous.

We must not forget that Russia, next to the United States, is the greatest wheat producing country in the world, producing over one-fifth of the entire crop of the earth, and yet, if she should establish a stable government she will at once become an importer.

Very much has been said of the Australian wheat crop, but Australia under normal conditions produces rather less wheat than Spain. Besides, under present conditions the famine in India, which is the third wheat-producing country in the world, is so great as to require that the Australian wheat crop shall be moved in that direction.

The last crop in Argentina is small. Even at the best, it must be remembered that all of South America produced less wheat than either Canada or France before the war, and that Argentina produces less than Italy.

Last of all, we are easily deceived about our own supplies. The wheat crop of the United States is harvested during the four months from May through August, and another month would include the entire North American product. Under ordinary conditions, this crop makes its way into the market somewhat slowly, and usually a great amount is held back by the producer for the increase that follows the harvest season. This year, however, the price was fixed. There was no reason for holding the crop even twenty-four hours, to lose in weight by drying or in amount

by insect and rodent depredation. The cry for wheat had become insistent and every influence operated to put this crop quickly and completely upon the market. It taxed transportation to the utmost, particularly as we were still in the war. The storage capacity of the country was not equal to its reception and the problem at once arose of getting rid of wheat in every conceivable way. It was for this reason that Mr. Hoover took off the lid and told us to eat it up, even while he knew that thousands of people were in distress for the wheat that we did not need but which they could not get. The same thing is true of other products. We had fallen into the habit of saving waste and as a result we have been overtaken by the flood tide; and that is why we can pull down our conservation signs.

However, should conditions suddenly improve across the water and should the distressed people there be able to transport and pay for the food which they sorely need, the call upon America will be sharp and our supply will be inadequate. That is why Mr. Hoover has said that when the fixed price is removed, wheat may again go to $3.50 a bushel.

Taken all in all, the situation is no longer one of distress so far as the Allies and ourselves are concerned, Russia excepted. So far as all other parts of the world are concerned, food is yet the most critical question before humanity. Such a war as this cannot be fought without famine and its attendant pestilence. It has never yet been done and doubtless never will be.

From the standpoint of production, the great question now is the rapidity with which the world can get ready to buy. Europe clearly has need of food long before it can produce it, so that if the world is to be fed in the next few months it must draw heavily upon the United States,—just how heavily no man is able to predict.

MEDICINE AND PUBLIC HEALTH SINCE THE WAR

C. St. Clair Drake, Director State Department of Public Health

The request of your Secretary that I discuss the effect of the war on medical and sanitary science and the responsibilities and opportunities of medical and sanitary science under conditions following the war, is a large order and one which I hardly feel qualified to fill. The knowledge I have of the development of military surgery, of the brilliant advances in plastic surgery, of the investigations that have been made of the physical conditions and injuries peculiar to this war, comes to me at second or third hand and in no more authoritative form than it has come to the other members of this Association in the popular and technical periodicals. If what I have to say contains anything which is original or authoritative, it must consist of a discussion of the advances which the war has brought about in the field of preventive medicine and of sanitary science. It is to be regretted that the breadth and scope of this program made it impossible to include a physician or surgeon who could review briefly actual war-time accomplishments in the field of medicine and surgery. For, we are led to believe that the medical history of this war, when it is written, will be a tremendous contribution to the medical and surgical literature of the world. However, there is enough to be said on the progress of preventive medicine and public health to more than occupy the time which is assigned to me today.

The immediate effect of our entering the world-war was the realization that our man-power is quite as important, if not more important, than our monetary wealth and industrial power, and further that the strength of our man-power is determined, in the last analysis, by the individual

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health of the men of the nation. It was impressed upon us that it was not only essential that we should have men free from disease and physical defects for the military service, but that it was quite as essential that we should have strong men and women to meet the demands of the tremendous speeding-up of our industrial activity.

The actual story of accomplishment in the prevention of disease during the war is effectively summarized by Colonel Victor C. Vaughan in a recent publication and under the caption, "The Fruits of Preventive Medicine." In this very striking article Colonel Vaughan says, "By making use of our increasing knowledge of medicine and sanitation since the civil war times it has been possible during the war just closed to prevent 500,000 cases of disease and save the lives of 10,000 soldiers."

Colonel Vaughan contrasts the sickness rates prevailing among the Northern armies engaged in the Civil war with those of the American Army engaged in the recent world-war, and sets forth the following extraordinary facts indicating the progressive tendency of preventive medicine and sanitation, and the part which they have played in winning the war for democracy. According to Colonel Vaughan the incidence of typhoid fever has been reduced over ninety-nine per cent; minor intestinal infections have been reduced ninety-six per cent and malaria has been reduced to the same extent. Inflammations of the mouth and throat have been reduced to eighty-seven per cent and pneumonia sixty-five per cent. Measles, which was one of the serious menaces in Civil War days and whose epidemiological problems are not fully mastered at the present time, was reduced thirty per cent, while the incidence of tuberculosis, aptly termed "The captain of the men of Death", has been decreased fifty per cent.

For a number of years, health officers and physicians have urged the periodical physical examination of all persons to determine the existence of serious disease in its incipient and curable stage. While some progress has been made in this line, we have all been so engaged with our personal, professional and business interests that we have ignored individual health and precautionary measures to a large extent.

The physical examination carried out by the Exemption Boards in the creation of the new National Army, however, gave us a definite idea of the extent of which serious disease prevails in the rank and file of the people, generally unrecognized by those individuals until relatively far advanced.

The results observed by some of these Exemption Boards were astonishing and aroused the more or less preoccupied public officials to an activity which the nation had never before known. The American people, with admirable spirit, accepted the dictum that every public and private interest must be regarded as secondary to the successful pursuit of the war, and to this end traditions, customs and prejudices were swept away as they could not have been under other conditions.

Without the records of the first draft, which, unfortunately, were not preserved, it is estimated that over seventy-five thousand young men were rejected by the Exemption Boards on account of tuberculosis, and it was found that, with the necessarily hasty examination made by these Boards, thousands of others had been passed who were suffering from this very evasive disease. On this account, and very largely through the personal influence of Colonel Frank Billings of Illinois, the Surgeon General of the United States Army designated over two hundred tuberculosis experts to re-examine the recruits in the camps and cantonments with the result that approximately twenty-five thousand young men were discharged from service on account of tuberculosis.

The importance which the Federal Government and all European nations attached to tuberculosis as a war-time problem, made it very easy for state health departments to formulate new rules and regulations for the control of the disease, requiring the reporting of all known or suspected cases to the local health authorities and empowering such authorities to isolate and segregate the victims of open disease.

A feature of the regulations promulgated in Illinois as a part of a very comprehensive tuberculosis war-time program, is the requirement that the physician shall advise the patient and members of his family as to the exact na-

ture of the disease, thereby overcoming that unfortunate secrecy which has caused untold thousands of consumptives to lose their opportunity of recovery.

On account of a false sense of modesty upon the part of the people, or on account of the unfortunate manner in which educators had approached the subject, relatively little progress had been made throughout the United States in the campaign against venereal disease until our participation in the war. For the most part, venereal disease literature had been written in a style which indicated that the author regarded his subject as an improper one, or, upon the other hand, colored with such lurid hues as to make the subject morbidly interesting. The recognition of the tremendous prevalence of gonorrhea and syphilis in the armies of Europe, and the confirmation of a similar condition among the young men of the United States through the reports of the draft boards, caused the Federal and State governments to take a firm hand in the venereal disease campaign and to approach it in the same sane and practical manner that they have approached other communicable diseases. The change which venereal disease literature has undergone during the past year is quite astonishing, and the response of the people of all classes to this educational campaign has been equally surprising. There is now good reason to anticipate that, on account of the impetus given the subject by the war, a successful fight will be made against social disease on a simple public health and disease prevention basis. Questions of morals and of religion, which formerly confused this subject, have been generally eliminated and the problem has been attacked with the same frankness and candor that marked the action of the Surgeon General's office in establishing stations for preventive treatment in the various camps and cantonments.

Illinois was the second state in the union to join with the Federal government in its battle against venereal disease, and the rules and regulations of the State Department of Public Health, which were first applied in the zones surrounding military cantonments and later extended throughout the entire State, have been accepted as practical in application, rigid enough to produce salutary results and yet not so drastic that they would produce unfortunate reaction.

The war and the necessary protection of the fighting forces made it possible to seize the prostitutes in the five mile zones surrounding military camps, and to subject them to thorough examination. Moved by the exigencies of the war, the courts were ready and willing to impose sentence which was suspended so that these unfortunate women might be placed in hospitals for scientific treatment at the expense of the county in which they were found. The program which is now being carried out, and which will continue to be carried out throughout the state, gives better promise of the control of isolated vice districts and the reasonable suppression of vice than any program that has been contemplated or adopted in the past. The quarantining and placarding of premises in which there are persons venereally infected, seems to go further than any form of police regulations. This program is no more drastic than conditions of peace-time would warrant, but I feel satisfied that the tremendous strides which have been made could not have been accomplished in a decade had it not been for our participation in the war.

The accent which has been placed upon the importance of sound physical condition of the people, together with the almost prodigal liberality of the federal government in attaining desirable ends during the war, will have its effect upon the public health history of the nation for all times to come. The Federal government has appropriated large sums of money for the warfare against venereal disease, and is meeting state appropriations with dollar for dollar grants of funds.

Early in the war, when men were found to be tuberculous or physically unfit, they were discharged from military cantonments either as "in line of duty" or "not in line of duty", depending upon the length of time they had been in service. After a few months, this policy was abandoned and every man who was accepted in a military cantonment was regarded as "in line of duty," the Federal government assuming the responsibility of his financial compensation just as though he had sustained his disability through wounds on the field of battle. As months went by, and as troops began to return from the front, the government policy was made even broader and more generous. Instead of being discharged with pensions or financial grants, and

permitted to make their way through life as the victims of physical defects, the Federal Government, as far as possible, is retaining the sick and wounded and disabled in service, assigning them to special hopsitals where they not only receive medical care of the highest type, but where they are being re-educated to a condition of self-sustaining efficiency.

At the present time, if the sick or wounded soldier will avail himself of what the government urges him to accept, he will be returned to civil life physically rehabilitated and ready to resume his former occupation, or he will be specially trained in a new means of livelihood adapted to his physical condition. Merely as a minor part of this great program of reconstruction the Federal Congress has recently appropriated the sum of seven million and fifty thousand dollars for the erection and maintenance of tuberculosis sanatoria to be operated under the direction of the United States Public Health Service.

As important as the steps of this reconstruction policy may be, and as great as the public investment in health, I still feel that the secondary or remote result of this great program will be more important to the nation, as a whole, than the direct or immediate result. That is, I feel that the realization of the value of individual and community health, brought about by the war, will not be forgotten, and I am convinced that the policy of generous appropriations and generous expenditures for health purposes will be continued not only by the federal government, but by the states by local communities. The influence of the liberal policies of the government in attacking health problems during the war bore fruit in Illinois when at the autumn election of 1918, the people of thirty-three counties voted by overwhelming majorities to establish county tuberculosis sanatoria, free tuberculosis dispensaries and visiting nurse service. While Illinois has sorely needed these institutions and has apparently been very reluctant in the past to adequately meet that need, I am satisfied that such a result could not have been attained at this time except through the awakening influence of the war.

In times past, child welfare work,—the effort for the conservation of child life and the protection of child health —has been regarded by the average citizen as a phase of public health activity of only moderate importance. The

attitude of European nations and especially the findings of of our exemption boards, have radically altered our conception of the importance of child welfare work. Strong manhood has its foundation in infancy and childhood, and, as never before, rugged manhood is recognized as essential to the nation which seeks industrial, intellectual, financial or military supremacy. On this account, in this country as abroad, child welfare work has been given an impetus such as it has never had before which will result not only in a material lowering of our present shocking infant mortality; but which will cause a very different showing if we ever have a selective draft in another generation.

The examination of several hundred thousand school children, which was brought about on account of the stimulated interest due to the war, has brought forcefully to our attention the fact that physical defects are more common among children in rural schools than among those resident of cities; accentuating the importance of sanitary and health work in rural communities which has been overlooked to a considerable extent, through the former conception that rural life and healthfulness necessarily go hand in hand.

Incidentally, our experiences with communicable diseases, in mobilizing and maintaining an army, has caused public attention to be more definitely centered on these preventable ailments than could have been possible under any other conditions. The ravages of measles, of pneumonia and influenza in our camps at a time when the outcome of the war seemed to depend upon our organizing a gigantic force of fighting men, caused the American people to think seriously in terms of preventive medicine and to appreciate the importance of these diseases in their own communities. The complete elimination during this war, of typhoid fever—the disease which played such havoc in the war with Spain—has caused our people to realize that typhoid fever need not be endured in times of peace.

The absolute prevention of smallpox among hundreds of thousands of men has accented the truth about vaccination,—a truth whose neglect is manifested by the repeated invasions of this wholly unnecessary disease.

Camp sanitation with the destruction of the breeding places of mosquitoes, with consequent prevention of malaria and yellow fever among the troops in southern

states, has greatly interested the average citizen. While the influenza epidemic, sweeping away thousands of our much needed troops came as a tragic lesson of the utter futility of governmental endeavor in the face of the outbreak of disease.

When the influenza epidemic was at its height, the public press reflected the fear entertained by many high officials, that communicable disease might spell defeat for the allies, and, for the nonce, public health stood in its correct position,—the paramount subject of the nation.

While the influenza epidemic was responsible for twenty-five thousand deaths in Illinois, and between five hundred thousand and six hundred thousand in the nation, constituting perhaps the most serious scourge the country has ever seen, it is not unlikely that the benefits which will accrue from the tremendous arousing of public sentiment through the epidemic will more than compensate for its frightful cost in human life and human suffering. The epidemic seems to have been, at least indirectly, a result of the war. Its explosive invasion of many states having its origin in the large concentration camps. The regulatory measures in which the public readily acquiesced during the epidemic have already borne material fruits. On account of the medical school-inspection required in communities where schools remained open, the communicable disease of childhood have been less prevalent in Illinois during the past winter than at any time during the history of the State Department of Public Health, and people have seen the advantages and necessity for the expenditure of public funds in the safe-guarding of community health as they have never done before.

This enforced concentration of public attention upon matters of public health has had a natural tremendous influence in the more progressive communities of Illinois, and, from studies recently made by the State Department of Health, there is ample occasion for grave concern over the problem of disease prevention in our cities and villages and rural communities.

Terms of dollars and cents are more readily intelligible to most of us than terms of grief and sorrow and human suffering, and the studies of the cost of preventable diseases made by the Department are staggeringly convincing.

Estimating the cost of human life, the loss of time in gainful occupations, medical and nursing care and the expense of burial, it is found that eleven communicable diseases during the year ending July 1, 1918, cost the people of Illinois approximately $155,000,000, or $24.67 for every man, woman and child in the state. The per capita cost to the various counties ranged from $4.72 in Stark County to $124.16 in Kendall. In one county this loss equalled 37.61 per cent of the valuation of the total assessed wealth.

Of this gigantic sum $115,000,000 was due to tuberculosis; $30,010,000 to pneumonia; $3,007,000 to typhoid fever; $2,660,000 to malaria; $1,157,000 to diphtheria; $735,000, to whooping cough; $675,000 to smallpox; $461,600 to poliomyelitis; $456,000 to measles; $426,000 to epidemic meningitis; $388,300 to scarlet fever. It will be borne in mind that these figures are for the year ending last July and do not include the months of the epidemic of influenza.

The experiences of the war, in handling hundreds of thousands of men, closely crowded together, with typhoid fever, smallpox, and malaria absolutely eliminated, suggests a definite and certain saving of great magnitude which can be brought about in Illinois by relatively simple means now available to us. Greater savings in dollars and cents, but not so easily demonstrated, may be made through intelligent attack on the other communicable diseases.

For successfully meeting the problems of disease prevention and health promotion whose importance the experiences of the past two years have revealed so clearly, the war has provided a personal and a public sentiment which will be tremendously effective if properly utilized. A large number of physicians have gone into military service from every section of the nation. Some of these men have been assigned to sanitary service in the army and have received excellent intensive training. All of them, regardless of their branch of service, have had impressed upon them the paramount importance of maintaining the men about them in the highest degree of health and efficiency. In the army they have seen flagrant violations of health regulations looked upon as nothing short of crime, and they are all returning imbued with the necessity for a

closer and more rigid adherence to the laws of public health. Many of these physicians, having had their first experience in executive positions and in preventive medicine, will be reluctant to return to the humdrum of private practice, and out of their ranks we should be able to obtain the full-time medical health officers essential to the proper safe-guarding of every community.

In addition to these medical officers who will come back to us from the war, there has also come the great army of soldiers in line who will create a new sentiment in regard to public health control. These young men who enlisted in service from every city and village, and from all walks of life, had impressed upon them in a way that they will not forget, not only the advantage of keeping physically fit, but the obligation to maintain the highest degree of health as citizens and soldiers. They have seen examples of effective disease prevention. They have seen the price that must be paid in the ravages of communicable disease. They have had impressed upon them the necessity and the reason for ready and cheerful submission to sanitary rules and regulations.

The nation has never had before so many young and progressive men active in the affairs of their own community, trained to the necessity of public health supervision as we have today, and the nation has never had so many men capable of leadership in the field of preventive medicine. These forces have come to us from the war, and their intelligent utilization will bring such benefit to the state that our war-time casualties and losses will sink into relative insignificance as compared with the saving of human life which the war thus indirectly will make possible.

The sentiment created by the war has caused the people of Illinois to be ready for progressive legislation for the conservation of health which in all likelihood will be introduced in the present session of the General Assembly. One bill which is attracting wide attention is that requiring a full time medical health officer in each community in the state. I am satisfied that the introduction of this measure will find the General Assembly and the people at large thoroughly responsive to it, and that within the next few years there will be established in Illinois a public health organization whose incentive and whose personnel have been for the most part, the contribution of war-time conditions and war-time sentiment.

THE OUTLOOK FOR GEOLOGY AND GEOGRAPHY

F. W. De Wolf, State Geological Survey, Urbana.

1. Experiences of the War

Before speaking of the outlook in geology and geography it will be worth while to consider briefly some applications of these sciences to war activities in the several armies.

The usefulness of geology and geography in the war is not generally realized. Indeed their possible use, either directly or indirectly, seemed unlikely to those in responsible charge of the American program, until the scientists themselves had by persistence shown that these earth sciences have many practical applications to warfare, and to those home industries necessary to sustain the army and the nation. However, the government accepted these professional services gradually; rapidly in some lines and slowly in others. The strenuous efforts made by groups and by individuals to bring this about would make a most interesting and entertaining story if it could be fully written. It is enough to say of the efforts, that they succeeded to a marked degree before active fighting stopped, and that geologists and geographers were giving increasing service with the following agencies: the field army, the military intelligence, the officer training camps, the war industries, war trade, and shipping boards, the fuel administration, and the House commission engaged in preparing for the peace conferences. The work of these men made a splendid impression, and a brief statement covering some of it will be enlightening.

Of first importance was the making of accurate topographic maps of large scale for control of artillery fire. About one hundred commissioned topographers from the U. S. Geological Survey were engaged in the work on the American lines, and in cooperation with the French. A map-printing plant, larger than the combined plants in

Washington and capable of producing nearly 1,000,000 maps each month was erected and operated. Many of the maps were revised and reissued daily. As a result, all officers now realize as never before the dependence of an army on topographic maps.

Related to map-making was the building of relief models. These were used in studying the visibility of the country from observation posts; and assisted in controlling shell-fire on enemy targets. Finished models showing relief and villages and roads were made by the thousands, and in the remarkable time of a few hours for each original mold, after which any number of fac similes could be made quickly.

Another vital need of the army was an enormous supply of water for men and horses, for concrete construction work, and for power plants and locomotives. Geologists made maps showing locations of springs and of shallow and deep water-bearing rocks. They also supervised the boring of wells, especially in the British army.

Supplies of rock, gravel, and sand were also needed in large amounts for building roads, gun foundations, dugouts, supply depots, and harbor works. Geologists assisted in locating the material.

Finally, maps and diagrams were made of the rock formations along the lines held by our army, and by the enemy, in order to show their suitability for the construction of trenches, dugouts, and mines. It was possible to observe existing works, and then to predict the conditions in new areas which were geologically similar. Thus, it was possible to say in advance whether trenches would stand without revetment of the walls; whether they would be wet or dry during certain seasons; and to advise regarding tools which would be needed to construct defensive works. Maps were prepared to show the probable effect of artillery fire on the formations; thus, whether the rocks would shatter and add to the casualties; and whether barrage fire would make the ground impassable for tanks.

These various uses for geologists in direct warfare were developed by the allied armies in varying degrees, but the Germans had prepared a systematic organization in advance, or at an early date. Our geologists and geographers

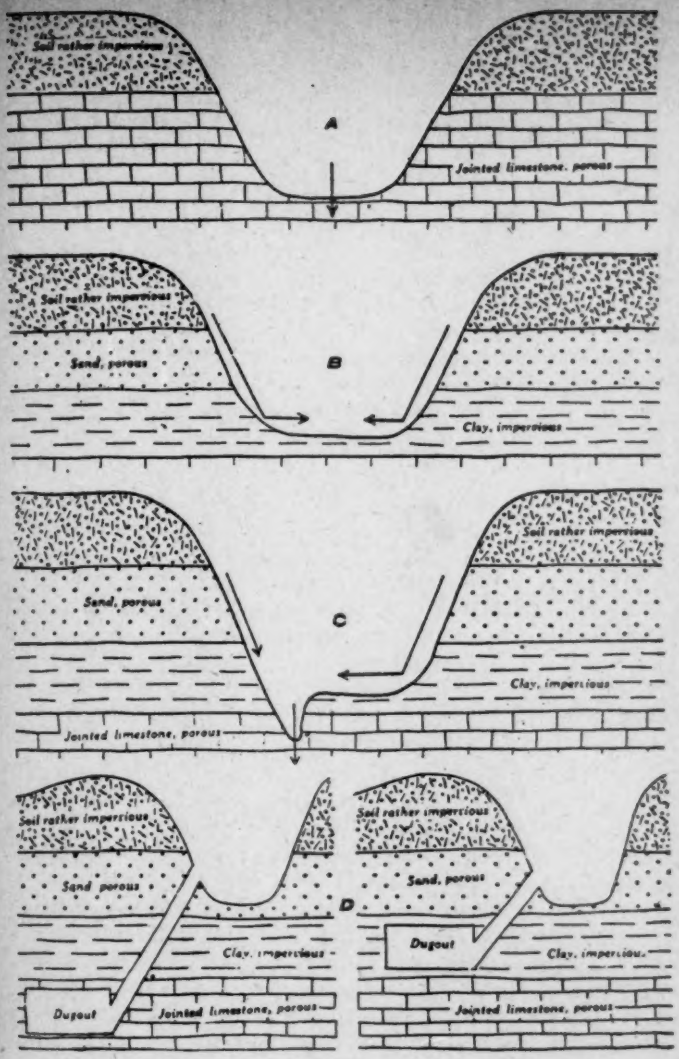


Fig. 1. Illustrating correct and incorrect methods of locating trenches and dugouts.

A. Correct trench construction. Water escapes through the porous jointed limestone.

B. Incorrect trench construction. Water is held in trench by impervious clays.

C. Correct trench construction under same conditions as "B", when it it is not feasible to sink the whole trench to the level of the porous limestone as in "A".' A small drainage trench carries water down into the porous limestone, permitting its escape.

D. To the left, properly placed dugout. Drainage takes place readily through the limestone, making the dugout relatively dry. To the right, improperly placed dugout. Water fails to escape through the impervious clay and the dugout is subject to very poor drainage or even flooding.

at home tried unsuccessfully in 1917 to have techincal units organized for service at the front, and to introduce certain kinds of instruction in the officers' training camps. In 1918 these hopes were partly realized when a number of geologists and geographers were commissioned in the war college intelligence office, and the geological service with General Pershing began to expand. Later, the educational committee in charge of the S. A. T. C. courses planned to require certain courses in map reading, map-making, and military geology. For this purpose the Geology and Geography Division of the National Research Council prepared three textbooks covering military geology, meteorology, and the geography of western Europe.

Aside from these military efforts, the most active service of American geologists during the war was in the development of domestic mineral supplies for essential industries. The average citizen was aware of the threatened shortage of coal and of oil, but did not realize that we were dependent on foreign imports for manganese, chromium, and molybdenum for steel tempering; of pyrite and platinum for making acids for explosives; of graphite and clay for metallurgical crucibles and retorts; of antimony for hardening lead bullets; of potash for fertilizers; of optical glass for instruments; and of numerous other minerals for essential purposes.

Geologists pointed out that the development of domestic supplies of many of these minerals would lessen the danger of submarine attacks on vital commerce, and would permit the use of more ships for transfer of soldiers and munitions to Europe. The search for domestic supplies and the encouragement of production and use, was undertaken by the U. S. Geological Survey, the Bureau of Mines, the state geological surveys, and by mining engineers and metallurgists. The results of the work were so successful that many large ships were transferred to direct war service, and many of the industries formerly dependent on imported minerals were largely or wholly supplied from home sources. Furthermore, to relieve railroad burdens, many ordinary domestic minerals were located and developed in new places close to market.

Work of the kind just described was undertaken in Illinois by the State Geological Survey in cooperation with other state and federal agencies. Fluorite for optical use

was discovered, and sand for optical glass was investigated. The Survey demonstrated the practicability of recovering pyrite cheaply from our coal mines and made an estimate of possible output. Promising deposits of fire clay and ganister for making refractory linings were examined and tested. The efforts of former years to locate new oil fields were continued, new work was undertaken to prolong the producing life of our old fields by demonstrating methods of protecting oil sands from encroaching water. Other work of permanent as well as war-time value was the development of methods for using Illinois coal instead of transporting eastern coal and coke for the manufacture of city gas. These various special activities largely supplanted the usual work of the Geological Survey.

2. The Future Prospect

Having now reviewed the work of geologists and geographers during the war period, can we foresee any further development or any change in the application of these sciences for the immediate future? As a colleague has said: "For two years we have been sharpening the sword and applying every effort to perfect its cutting edge", now we are to return to the field, the laboratory, and the classroom.

What lessons have been learned regarding the practical value of the earth sciences to the world, the nation, the state, and the individual? What improvements are possible in research? What of the larger social and political value of a knowledge of natural processes, world-geography and of world resources?

In answer, we have gained an added conviction of the fundamental value of topographic maps for defensive and offensive warfare; in the selection of routes for highways, railroads, electric power and communication lines; in the development of drainage and of water supplies; in the search for, and development of, minerals and other natural resources. The topographic map of the United States should be completed, not in 80 or 90 years, according to the former rate of progress, but in twelve or fifteen years. The map of Illinois should not proceed at the old rate, which promised completion in 1960, but should be finished by 1930. The cost will be more than saved to the taxpayers by eliminating surveys for roads, water supplies, and other necessary developments throughout the entire State.

Similarly, geology has again demonstrated its practical value in locating water for domestic and industrial uses, and stone, gravel, and sand, for building of roads, railroads, and other structures. A state like Illinois, about to invest $60,000,000 in the beginning of a hard-road system, should first locate and investigate the materials which are available close to the selected routes. Furthermore, a state about to build a great waterway, should know the location and usefulness of the heavy, slow-moving mineral wealth in the adjacent territory which will help furnish profitable cargoes.

Again, we have seen in connection with minerals for war industries, the value of statistics of mineral production, of lists of producers, and of geological investigation of possible new sources of supply, in advance of acute need. Thus, in Illinois, we owe it to the nation, as well as ourselves, to collect accurate statistics, to complete an inventory of our enormous mineral wealth, and to encourage new or improved methods for its production, conservation, and wise utilization.

But while some of us, who needed no demonstration, have seen the justification of practical geography and geology, we have been dismayed to find, even in high places, that there was little, if any, advance appreciation of the military, industrial, and social significance of these sciences. They had been considered purely cultural and academic! No conception of their importance existed in the academies at West Point or Annapolis, in the intelligence service, or in the early organization of the boards for war industries, war trade, and fuel control. Representatives of the professions were repeatedly refused the chance to serve the country with their special talents, and finally gained the opportunity only by personal persistence, and in many cases without recognition of their profession. One cannot blame others for this condition, and I do not wish to criticize those who were doubtless following to the best of their ability the lines indicated by past education and experience. It is our fault that these subjects have almost disappeared from the high schools, and have never been so perfected as to be appreciated by engineers and by the general public.

Evidently the future problems of geology and geography include not only the better organization and pursuit of research, but the better dissemination of knowledge of the usefulness and significance of these sciences to every-day affairs. Our common schools and high schools should teach some of their required courses in terms of earth science. Our colleges and universities must develop *special* courses in geology and geography which will be recognized as essential to professional courses in civil, mining, chemical, and ceramic engineering, and to those in economics, sociology, and history. Many engineering schools now give such instruction without requiring geology. In the future it will not be sufficient to teach only general courses and others adapted to students who are specializing in the earth sciences.

Similarly, in the routine work of official surveys and bureaus, an effort must be made to meet more of the needs of the mineral industries by cooperation with them, and by making known the results of investigations in common language rather than in the stereoptyped form and professional lingo to which we have been accustomed. The maps presented should display more effectively and in more detail the character, usefulness, and distribution of the rock formations, while continuing to show also as formerly their relative ages and modes of origin. There should be more effective consultation and cooperation between state surveys and between state and federal surveys regarding development of purposes and methods, in order that official geology may be more practical than in the past, and also in order that fundamental problems of origin and correlation of the various formations and their enclosed minerals may be attacked on a national scale more vigorously than heretofore. Just as the experience of the war indicated the impracticability of centralizing all knowledge and all administrative power in Washington, and the consequent need for state councils, directors, and administrators, so strong, official surveys and bureaus are required in both the national and the state governments, and their work should be better correlated and more cooperative than in the past.

In regard to pure research in the earth sciences, it seems probable that much talent and time has been wasted in the universities and other research institutions by lack of

cooperation on a national and international scale. There has been too little knowledge of progress elsewhere, and of the relative value and timeliness of alternative problems to be undertaken. A most promising sign for the future lies in the proposed development of the National Research Council in this country, and of similar councils in many foreign countries. These councils will surely stimulate and systematize all scientific research, without improperly checking individual initiative and originality.

Following development along the lines which I have indicated, I trust the earth sciences will influence the United States and the whole world to a marked degree in the coming period. As a result of our participation in a foreign war for democratic ideals, and as a result of the world trade in which we shall engage, we must have a knowledge of foreign lands, their physical character, their resources, and their peoples, together with a better knowledge of our home country. A knowledge of human geography is to become of great importance to our whole population. Furthermore, for the solution of problems leading to social and political unrest, and for the universal establishment of justice, the world needs to *know* and to *rely* on the orderly and inevitable processes of nature, which are nowhere better exemplified than in the study of the earth sciences.

Papers of General Interest

THE MUSEUM OF NATURAL HISTORY OF THE UNIVERSITY OF ILLINOIS[1]

By Frank Collins Baker, Curator of the Museum.

In these days of strife, when Democracy, Autocracy, and Anarchy are fighting and seeking to control the world, such an institution as a museum, devoted to the peaceful work of interpreting nature's laws, is likely to receive scant consideration. It will be remembered, however, that early in the late war, England for a time closed the museums, art galleries, and kindred institutions, and otherwise curtailed the usefulness of these instruments of education; but the British public sent forth such a protest that the government hastened to reopen the halls and to encourage the people to visit such places, justly realizing that at this particular time such interesting places for healthful recreation are of the greatest value. And not long since, a report came from France, when a vindictive enemy was pounding for admittance within seventy miles of its gates, that a new museum had been founded to exhibit the history and use of the horse—from the time this animal roamed the plains and swamps of America, in those far off Eocene days when it was no bigger than a fox and had five toes, to the present time when it has become one of man's most faithful and important helpers. With these examples before us of museum activities conducted under the stern stress of war, no apology for such an institution seems necessary.

Value of Museums

Museums differ greatly in their relative values, but all, if rightly conducted, have a very real value to the community. Dr. G. Browne Goode, considered by many the father of the modern American museum, has defined the museum as "a collection of well written labels illustrated by specimens." And the noted English museum expert,

1. Contribution from the Museum of Natural History, University of Illinois, Number 3.

Sir William H. Flower, says of museums and their purposes, "It is not the objects placed in a museum that constitute its value, so much as the method in which they are displayed and the use made of them for the purpose of instruction." This definition of the veteran museum administrator is perhaps the keynote to the modern expansion of the museum idea.

Museums are of many kinds; some are devoted to exhibitions for the general public and are supported by municipalities; others belong to learned societies, universities, and even private individuals. At the present time more than 600 such institutions, large and small, are known in the United States, and many exist in Europe and other parts of the world.

But it is the university museum to which I wish to direct your attention at this time. It has been urged by some educators that the methods in use in the larger museums of the great cities are not alppicable to a university museum; and one wonders why such an opinion should be held because the new museumology is highly educational and of all places it should best fit into the educational plans of a seat of learning, such as a university.

The great public museums, during the past twenty years have passed through a period of active evolution and they have now attained a measure of organization which makes them efficient factors in the educational systems of the larger cities. University and college museums are now passing through the same period of evolution. A few university museums have forged ahead, but the majority have scarcely passed the old stage of the cabinet of natural history so much in vogue two generations ago.

What, then, should be the character of the natural history museum of a large university and how may the collections and exhibits be made of general educational and instructural value? The exhibits should be so arranged as to bring out clearly the phenomena of life observed in nature. These may be a direct help to the instructional staff by providing illustrative material amplifying the information given in the texts and lectures; a synoptic collection, for example, may be so arranged as to give the student a birdseye view of the whole animal kingdom such as would

be impossible from the study of texts alone. Such an exhibit is made intelligible by means of models, drawings of the animals, diagrams of their structure, and descriptive labels binding the whole exhibit into a comprehensive unit.

The student may get from the museum an interpretation of the many phenomena observed in nature which are totally incomprehensible to him without such aid. The interrelationships of animals and plants may be shown by means of groups, transparent photographs, and specially arranged specimens. Under the skilful hands of the artist, the sculptor and the naturalist the animals and plants in natural groups are made to live again and to show in an interesting manner their modes of life, their associates, both friends and enemies, and the working of the great biological laws that are ever adjusting these creatures to their environment.

The testimony of the rocks, under the hand of the trained geologist, may tell us of the great drama that has been played during the long period of time that has elapsed since the dawn of life on our globe, and by the proper arrangement of the objects that we call fossils, which are the bodies of the actors, there may be unfolded a continuous picture of the different acts in this great drama, during which life has passed through so many changes and has finally culminated in Man, who thus boldly chronicles the history of his long pilgrimage.

The museum may not alone be confined to the exhibition of those objects related to pure science. Here the student taking a commercial course may study the evolution of some common commodity from the raw material to the finished product—pearl buttons from river mussels and pearl oysters, silk from the silkworm, cloth from the cotton field, oil from petroleum, and so on down the list. And the farmer may come to the museum and see in a group the enemies of his corn field, his orchard, and his grains, and he will be able to comprehend better, after seeing the carefully prepared groups, just how the insect damages his crop and also how best to combat this enemy. Of course, all this information is available in the literature, but a model will give at a glance more real information than pages of description.

The museum is also of real value to another class of students not usually considered when thinking of a museum of natural history, namely, the students who casually visit the museum out of curiosity, invited by the queer and unfamiliar objects, or from the "exploring" instinct so deeply instilled in the human species. These students, if interested, will acquire a fund of facts relating to nature which will be second only to that acquired by the regular students taking courses. In passing, it might also be added that the exhibits are of value to another class of students, those taking English composition and related subjects, for the objects in the museum are very suggestive for studies of this kind. Some of these classes in the University of Illinois have already made use of the museum for this purpose.

And thus one might go on enumerating the various subjects that can be treated in a museum of natural history that are of value to a university, but the inference is plain and need not be dwelt upon further. In addition to all that has been said, the museum affords a place for quiet and healthful recreation and often provides a stimulus to the enthusiasm of many students. It must be remembered, also, that a museum is always on the job, continuously teaching all who will but tarry long enough to examine the exhibits. They are thus perpetual instructors.

Aims of the University of Illinois Museum

It is the aim of the Natural History Museum of the University of Illinois to provide all that is inferred in the foregoing discussion. The lack of room, aside from insufficient funds, is the chief drawback to the proper expansion of the museum exhibits. It is probably not generally known by either the student body, the alumni, or even the faculty, that the museum possesses enough material at the present time to require a building as large as the University Library for its proper display.

It is quite pertinent to note here briefly the character and extent of the collections now in the possession of the University Natural History Museum. Perhaps of chief interest is the material brought back by the Crocker Land Expedition from Northern Greenland. This includes many fine specimens illustrative of the culture of the

north Greenland Eskimo, embracing weapons of the chase, wearing apparel, domestic implements, games, toys, etc. This collection, contrasted with a somewhat similar one from Point Barrow, Alaska, represents quite well the difference in the cultures of the two groups of Eskimo represented by these regions. From this northland the expedition also brought back enough musk-oxen, caribou, polar bears, blue foxes, and other smaller mammals as well as birds, to make a very instructive exhibition of the fauna of this Arctic region.

Of insects the museum possesses the great Bolter collection containing upwards of 100,000 specimens of insects from many parts of the world, but particularly representative of North American species. Stored in the Physics Building are many fine specimens of corals, echinoderms, mollusks, and other invertebrates, from many parts of the world, but chiefly American, which aggregate 50,000 specimens. These include an almost complete series of the Unionidae or fresh water mussels of our rivers obtained by that veteran collector, Mr. A. A. Hinkley. In addition there are several thousand fossils from American formations. It is not making too large an estimate to state that the University Museum possesses at the present time about 200,000 specimens as a nucleus with which to build up a modern Natural History Museum.

To fulfill its ideal function the museum must be developed along two quite distinct lines. First, the exhibit series, which may be made of educational value to many departments in the University. This series should contain synoptic collections of both living and extinct animals and plants; evolution series showing the development of many forms of life through past geological periods; series illustrating correlation of structure with function; geographic distribution series; habitat groups showing the ecological relation of animals and plants to their environment; showing the relation of natural objects to agriculture, industry, and commerce; series showing the geological history of the planet upon which we live, including the minerals and ores obtained from the rocks; and many other topics which can be treated by the exhibition method.

The second line of development is the study or research series. This should include large series of specimens,—animals, plants, fossils, minerals, etc.,—which may be

used for research purposes and which would be the basis for scientific papers. It is highly desirable that the University should accumulate a large amount of research material which has been used for the advancement of Science, that it may draw men to study this material in connection with further advancement of knowledge. Such collections should be placed in comfortable rooms, systematically arranged in easily accessible cases, the different subjects occupying separate rooms. The possession of type material places a museum in a position of value and usefulness not possible for an institution not having such collections. A good beginning has been made in this line of development and new material is being added very rapidly. Collections which have formed the basis for one large volume and a number of smaller papers are now in the research series of the Natural History Museum.

The present available exhibition space in the Natural History Building is limited to the small museum hall and the corridors on the three floors of this building. A synoptic series of animal life, including both living and extinct groups, is being prepared and is partly completed and on exhibition, which will fill half of the space in the museum hall. This includes selected, typical specimens representative of the higher groups; models, diagrams, drawings, and full descriptive labels. A model showing the twelve most injurious insects that infest the corn plant has been prepared, the group containing models in wax of the corn plants with the insects in all stages of growth feeding upon the plant. Carefully prepared labels describe the insects and their work and are made simple enough for the average farmer to understand. A habitat group, with a photographic enlargement of the old Brownfield woods near Urbana for its background, and with the plants characteristic of such a locality, shows the animal life in and about an old decaying log. Other exhibits along these educational lines are in preparation.

A number of our American universities possess museums of large size,—Harvard, Yale, Princeton, Pennsylvania, Chicago, Michigan, Iowa, Kansas,—and some of these museums contain material that has formed the basis for classical works in the Natural Sciences. Why should not Illinois also be numbered among these universities with a museum containing valuable and interesting collections

made available for the lay visitor, the undergraduate, the research student, and the scientific specialist? And why may not Illinois be a leader in museum work among the universities? The time is not * * distant when a museum building will become a necessity on the campus, a building which may not be numbered among the largest of museum edifices, but which may well be one of the best buildings devoted to the particular needs of a university community and an efficient aid to the educational forces of the University in nearly all its departments.

To hasten the realization of the aims outlined, may I ask the cooperation of the members of the State Academy. There are doubtless collections in different parts of the State that could be obtained if their owners knew that special attention is now being given to the development of the museum along modern lines. Many of the members may be in position to make collections during their summer vacations and these might form really valuable additions, especially if the material came from a locality which was little known scientifically. Much of the material obtained in this way is of considerable research value, frequently revealing new species to Science or adding information of value concerning geographical distribution or variation. The alumni of the University should be especially active in the museum's behalf, as is the case with many of the universities previously mentioned.

In closing let me express my appreciation of the labors of my predecessor, Professor Frank Smith, of the Department of Zoology, who laid the firm foundation for the development of the museum along the lines outlined above, and who established a standard of equipment and a system of record that has made possible the present and future development along the most approved modern lines.

A PROPOSED NEW STATE PARK

H. S. Pepoon, Lake View High School, Chicago.

I am before you today to present and speak in favor of a Proposed New State Park, the Canyon Park, located in Jo Daviess County on the upper approaches of Apple River, a small tributary of the Mississippi. It seems hardly necessary for me to argue in favor of such a place of recreation, before a body of enlightened men and women such as constitute the Illinois Academy. All of you, doubtless, will subscribe to the proposition that within reasonable limits, all the more remarkable natural feature of a state ought, at least in part, to be preserved as playgrounds for our own and succeeding generations.

Let me, however, briefly, as stirring up your remembrance of the vital points of such a contention, that this may in turn be used by you on any doubting Thomas, state them as briefly as possible:—

The first desideratum of any commonwealth is to possess a vigorous, contented, and ever improving citizenry. In these times of fierce and uncompromising strife for commercial advancement, personal betterment, and all that goes with the modern struggle for individual and community success, the strain of labor becomes more and more imperative and exacting, and the absolute necessity for relaxation is an equally imperative call. No man, young or old, can, with impunity, and without serious danger, toil ever without play spells; for if he is able to do so physically, the reaction on the higher qualities of mind and soul are disastrous. My first contention, therefore, is that a man or woman to keep normal must play at times, must relax and give place to these higher qualities, that, in their cultivation, he or she personally, may receive enlarged benefits, and the state have developed a better and more desirable people.

Junction of Rivers, Head of Canyon

In the Canyon

My second point is, that no method is more sure of mind and soul enlargement, so that broader and higher vision may attain than to send to the hills and woods, these tired and business befogged men of affairs, and let them absorb from the ozone of air and rock, water and leaf, new and more extended outlook, with broader horizon and higher vault of heaven, with purer and sweeter breath of life, and with food and drink stimulating to more perfect growth in manly power and experience. The man who drinks in the love of Nature and studies her varied phases, is not a wrecker of the commonwealth or a despoiler of her best interests.

And again, I hold, that these schools of God's Outdoors are not merely the best places for broadening the characters and forging principles of eternal right and justice, because their influence is always uplifting and never at variance with normal development; but that further, the State has no force at its command, that, for the minimum of expenditure will produce such a maximum of increment in citizens strong in body, acute in mind, clear in vision, broad in humanity, deep in reverence, loyal in patriotism; for Nature teaches no heresy and breathes no false doctrines of social or political expediency, but ever demands the best.

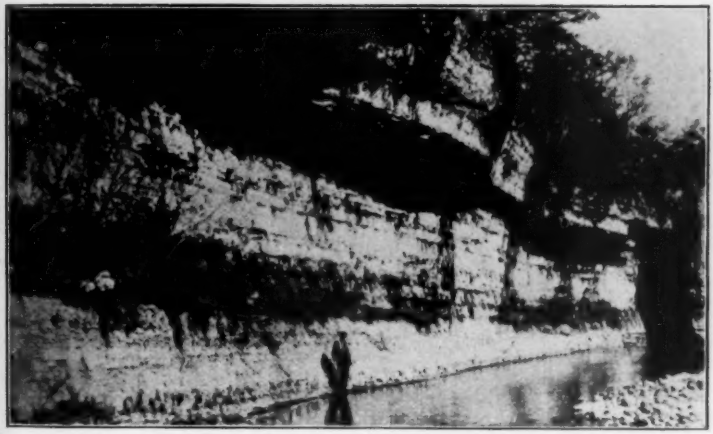
When we look at the condition of affairs in our own great state, we find her woefully behind her sister and neighboring commonwealths. It may be news to many of you that our nearest neighbors on the north and west, Wisconsin and Iowa, neither possessing but a fraction of our great wealth and resources, are far more long-sighted and provident than we are. Iowa has a law on her statute books permitting and appropriating a large sum annually for the purchase of large or small tracts of land possessing desirable features that ought to be preserved and conserved for the people. In this way a lotus lake here, a fine primeval forest there, an area of cliff and stream or a piece of original prairie are bought, and a well trained corps of enthusiastic men and women are ever on the search for any obtainable lands. In this simple and perfectly feasible way, Iowa has now between 20 and 30 state parks and reservations purchased or provision made for their acquirement. It is needless to say her citizens, from Gov. Hard-

ing down, are proud of this record, and well they may be, for who will be more benefited by such farsighted philanthrophy, (note the word "love of mankind") than the people themselves.

Wisconsin has already made provision for some 13 state parks, the largest being in Door County and at the mouth of the Wisconsin River, where some thousands of acres each have been reserved for perpetual playgrounds for her citizens. If one talks to those conversant with the ambitious plans of the Park people, there appears no question of the advisability and expediencey of such a movement, the only problem being how to obtain as many of the desirable beauty spots before they are ruined by commercialization.

When we turn to Illinois, a very different condition confronts us. We have *one* State Park at Starved Rock, beautiful in scenery and rich in educational and historic features, and rumor is, that one or two other insignificant plats of a few acres have been acquired. But how utterly inadequate is such a condition to meet the actually needed requirements of five millions of people! We ought to have 40 state parks—large and small—to provide for this host, and Illinois is abundantly able to pay for all such lands, receiving not dollars and cents of cash in hand, but what is far more important, better equipped men and women, who will add immeasurable assets to the commonwealth.

And so I present for your consideration, The Canyon Park of Apple River, and bespeak for it your hearty support. The region proposed comprises about 1,000 acres of the wildest, roughest and most picturesque lands in Illinois, lying along Apple River from the junction of the east and west branches five miles southwesterly. This canyon is a chasm eroded in the Galena limestone to the depth of 250 feet, and it has a bottom width of 8-10 rods. The walls on either side are 45° forested slopes or vertical cliffs, these alternating from side to side as the enclosed river meanders from the west to the east rim of the canyon. The highest cliffs are 150 feet vertical walls of gray or buff dolomite unevenly bedded, full of gash veins or contraction fissure, with many small caverns, isolated towers, castles, rock masses, and huge talus blocks of all dimensions. Everywhere a forest growth rich in species, clothes



Water-worn Cliffs

the canyon floor, the steep slopes and all but the most exposed and precipitous cliffs. Springs, seepage areas, and side ravines and miniature canyons are everywhere, and all abounding in a rich and diversified flora. Some sixty species of forest trees and 400 species of smaller plants, many exceedingly rare, add charm to the region and make it a veritable Botanist's paradise.

As a preserve for fish and birds it is ideal. As it now is Apple river is one of the finest small-mouth bass streams of Illinois, and certain kinds of trout would certainly thrive in its cold shaded depths. The angler would find here a a place of rest and recreation second to none in the state, with a park affording protected camp sites, with neighboring farmers supplying the daily menu, and with game in the rushing waters, to tax his best skill and endeavor, there would be little to complain of. For the bird lover the varied topography and the innumerable trees and thickets make a haven that birds find specially alluring. Protected from all piercing winds of winter, with many springy places giving water at all times, with seed and fruit plants galore, many forms linger late or even winter in the canyon. For example, a jacksnipe was enjoying himself immensely Christmas day, 1918, when the upland temperature was arctic. He had a deep side gully, filled with a living spring water full of algae and small animal life, so what cared he for wintry blasts? Nearby a flock of waxwings ate juniper berries, a pair of cardinals flashed their brilliant wings, and a horde of pine siskins made the air full of their dainty twitter, whilst across the gorge a long-eared owl defied a roystering band of crows.

Historically, here was one of the happy hunting grounds of the turbulent Sauks, and in the primeval white oak forest as it stood in 1870 ancient areas of cultivation were yet to be seen. Untold wealth of arrows, spears, hatchets, and other flints attest to the esteem in which this land of vale and hill, forest and glade, was held by the red man of long ago. The ancient stage routes from Ft. Dearborn and Dixon's Ferry join not far from Millville, at the canyon's head, and thence proceeded via Frink's barn to Galena, the ancient mining town of the Indians, French, and later, Americans.

Ethically, scenically, historically, geologically, biologically, here is an ideal spot for *one* of the many state parks Illinois must have to keep abreast of the time and the demand, and it is sincerely to be hoped that her legislators will arise to the occasion and acquire the same, as it can now be done for a not unreasonable outlay; so that generations now living and the untold number of those to come may bless the foresight, wisdom, and broad statesmanship of those thru whose efforts fruition was at length attained.

To give a little idea of the beauty and character of the topography, a few illustrations are appended. It is earnestly urged that all who can visit this region, and learn at first hand what it has to offer of beauty and wildness, recreation and rehabiliment for all the care-worn, business fagged, mentally benumbed citizens of our great commonwealth, who here may come to renew themselves with might in the inner and outer man.

CURRENT TENDENCIES IN SCIENCE EDUCATION IN THE SECONDARY SCHOOLS

J. L. Pricer, State Normal University

The last meeting of this Academy was devoted largely to a most admirable and thorough discussion of the subject of science education, and under ordinary circumstances, it would be unnecessary to discuss the subject again so soon. But it is true that during the last twelve months, some things have happened, in connection with this important matter, which are quite new and which need to be reported.

I can present these new developments in better light, if I may first review briefly, the main features of the more or less blind struggle toward better things which the students of these problems have gone thru during the past fifteen years. Altho I have been more or less engaged in these struggles during these years, I shall endeavor on this occasion, to view the whole matter as objectively as possible.

Fifteen years ago, all was comparative peace and contentment in this field. Secondary school science was viewed as simply so much subject matter, which had been fairly well crystalized and standardized, and which was to be imparted bodily to young people, at least partly by the laboratory method. The standard high school curriculum in science, here in the middle west, consisted of half-year courses in physiology and physical geography in the first year; half-year courses in zoology and botany in the second year; and year courses in chemistry and physics in the third and fourth years, and most students took all the science offered. About the only evidences of unrest at the time consisted of a little jockeying on the part of the friends of the several sciences for a better position in the curriculum for the favored subject, the fourth year of the high school course, being the one most desired.

About this time, however, the agricultural colleges and schools of home economics, which had reached a high state of development in the universities began to scan the secondary field, and soon, some of those who had the clearest vision of the possibilities of and the urgent need for a more practical education for the young people in the high schools, began to insist that courses in agriculture and in home economics be offered in the high schools. Now, since the science curriculum was already full, this demand usually took the form of a proposal to substitute these new subjects for some of the sciences already in the curriculum. This situation soon divided the friends of science education into two camps, under the banners of pure science and applied science respectively and a bitter civil war ensued, involving many odious comparisons of the relative educational values of the two kinds of science. This warfare lasted for five or six years during which time, the High School Conference at the University of Illinois, the Central Association of Science and Mathematics Teachers and other similar organizations, staged annually, royal battles over these issues. Even this Academy was drawn into the fray, and the symposium at the Urbana meeting in 1910 on the subject: "The Relation of Pure and Applied Science to the Progress of Knowledge, and of Practical Affairs" did much to help clear the atmosphere.

It is pleasing to relate that this war ended definitely and as suddenly as it began. I recall definitely that the battle was going on with all its fury at the meeting of the High School Conference in November, 1909, and that a year later, all the smoke of battle had cleared away. Everything that was said and done at the 1910 meeting of the High School Conference was marked by a spirit of conciliation and mutual understanding and appreciation between the late belligerents. What had happened? Simply this: Discussion, and thought and fair and open mindedness had cleared away the misconceptions which had been the real cause of the war. The friends of the older sciences had discovered that there are some real possibilities for good in the new ones, and that they have a real claim to a place in the sun. The friends of the newer sciences had profited by the criticisms that had been hurled at them, had gained a clearer vision of the true mission and place of their subjects, and had also discovered that some knowledge of the

older and more fundamental sciences was a necessary prerequisite to theirs. The friends of the older sciences were ready to admit that an academic knowledge of fundamental science alone, is not a sufficient education for the masses of young people flocking into the high schools. The war was over, science education had taken a distinct step forward, and the friends of science education were once more united in the interests of the common cause.

Not all the problems of science education were solved, however, when this peace was declared, for two new sciences, each demanding more space than was demanded by any of the older sciences had been added to the list which must compete with other subjects for space in the brief four-year high school curriculum. Instead of crowding other subjects, which had the force of tradition and inertia behind them, out of the high school, the numerous sciences began to crowd each other out. The statistics collected by the Commissioner of Education, began to show a rapid decline in the percentages of high school students pursuing the older sciences, and especially of those which happened to occupy the first two years of the course. Botany, zoology, physiology, and physical geography soon began to verge toward the vanishing point, and some of them have almost reached this point in some parts of the country.

In the midst of this perplexing situation, there suddenly appeared above the horizon, what seemed to many of us, another menacing factor in the form of an exceedingly effective catch-phrase, and slogan: General Science. At first, this phrase meant many different things to different people, but it soon gathered under its banner all people to whom it meant anything good, no matter what that meaning happened to be, and so it soon became a formidable factor. To some of its early advocates, it meant merely samples of all the sciences done up in small packages. To some it meant a much more substantial thing, namely: environmental science materials, attacked from the standpoint of the child's immediate interests and needs. To some administrators, it meant an opportunity to put all science into a small space and thus a satisfactory solution of their administrative troubles. To some of the conservative students of science education, it meant simply an-

other science seeking space in the already overcrowded curriculum. Being thus capable of so many different interpretations, it has been an ideal topic for argument, for difference of opinion, and warfare between the friends of science education, and so another civil war has been in progress for the past five or six years.

Along with general science came the *Project Method,* and this to most of us was at least a vague and indefinite stranger, and possible enemy in the camp. We made urgent demands for his credentials but nothing in the form of a satisfactory definition, or even a good illustration was forthcoming, and so we were against him.

I believe that nearly all of the partizans on both sides in these internal wars among science teachers are earnestly and honestly seeking to help the cause of science education, and I believe that the wars themselves usually arise out of the shortcomings of science teachings, but it is usually the case that the reforms needed are at first felt, rather than seen clearly, and so it seems almost necessary that the issues be threshed out by a period of discussion and experiment. But the most unfortunate thing about such a method of progress, is the tendency of the partizans to criticize so unmercifully and often so unjustly, the things that are being done in the line of science education. The most severe and unjust criticism that I have ever heard of botany, for example, as a high school subject, has not come, as one might expect, from some teacher of the humanities, but rather from some science teacher, usually a physicist, or a geologist, who has espoused the cause of general science. Such a person usually takes up the botany of twenty or forty years ago, when he was in college, and shows what a miserable thing it is as a preparation for life in these modern times, and then tries to show by contrast what a superior thing this brand new modern general science is. If we were never heard by anyone but ourselves, this would not be so serious, but unfortunately, we have been influencing a lot of innocent bystanders. The non-scientific administrator, who is perplexed by the numerous sciences from which he must choose his science curriculum, and who gets such conflicting advice from science educators, finds plenty of argument to support him in giving science little space, in the

criticisms of the different sciences, and the different ways of teaching science, which he hears uttered by science educators. There is nothing that we have ever done or proposed to do that has not been scathingly criticised by some members of our own group.

As a matter of fact, I am convinced that the results accomplished by the teaching of science in the secondary schools during the past fifteen years, have been quite as satisfactory and valuable as have been those accomplished by the teaching of any other high school subject, but we have been losing ground while some of the others have been gaining, and I believe that this is largely because of the strife and conflict within our own camp. Some other subjects like Algebra and Rhetoric have during part of this period, gained ground, probably more because their friends have been at peace among themselves than because of actual merit of the subjects. Doubtless this unrest and agitation among us is an evidence of life and growth, and we may profit by it in the end, but I believe that we might at least try to see to it that the criticisms we utter are just.

I now come to the new thing that I have to report, and it is that this last conflict which was aroused by general science and the project method, is suddenly over. Essentially the same treaty of peace was drafted independently, and unanimously adopted, both at a joint meeting of the science sections of the Illinois High School Conference, and at a meeting of the Central Association of Science and Mathematics Teachers, last November.

The first number on the program of the joint science session of the High School Conference meeting, was a very excellent paper by Dr. J. A. Stevenson of the University of Illinois, on "The Project in Science Teaching." Dr. Stevenson made perfectly clear to us what a real project is, and he summed it up in the following definition: "A project is a problematic act carried over to completion in its natural setting." For example, one may teach by ordinary class-room and laboratory methods, the life history, the breeding habits, the disease spreading propensities, and the common methods of destruction of the house fly. This is not a project, but a project may be made out of these same materials, by attempting a fly eradication

campaign in the community of the school. Such a campaign involves many problems which a class of pupils may work out under suitable direction, and if the flies are actually eradicated, the act is carried to completion in its natural setting. Now, if this is a project, there is nothing in it to be afraid of. Furthermore, it is not altogether new. I had carried out a fly eradication campaign in my community some years before I recognized the act as a project, and yet I believe that it is a perfectly typical example. So, the project, being not entirely new, being now clearly worked out as a definite and workable device, and being in this form an altogether desirable addition to our collection of recognized teaching devices, is no longer a cause for strife or difference of opinion.

Following this paper, we had a sort of symposium on the topic: "The High School Science Curriculum, with Special Reference to the Common Pabulum of Science." This consisted of five papers, one by a representative of each of the five science sections of the Conference.

All of these papers except one which was only a little discordant, and nearly all of the general discussion which followed seemed to be in substantial agreement with the resolutions which were finally adopted by unanimous vote of the meeting. The following is the resolution: "Be it resolved that we pledge our united support to the following program for science instruction in the high school:

First: Two full year-courses in what shall be essentially fundamental science; this work to be given in the first two years of the high school, or where junior high schools exist, the same work may be done in the eighth and ninth grades, or spread over the seventh, eighth and ninth grades; this work to be required of all students, insofar as it is administratively possible.

Second: As many full-year courses in the applied sciences, and pure sciences, should be given the later years of the high school course as there is demand for, and as the size of the faculty and equipment of the school will permit. These later courses, unless it be in the case of agriculture and home economics for certain groups of students, should be purely elective, and should be so organized and taught that each year course may answer as the equivalent of a first semester course in the subject in college."

Following the adoption of this resolution, a motion was made and carried, providing for the appointment of a committee of ten, whose duty it is to attempt to draft an outline for a suitable content for these two year courses, in fundamental science, which should be required of all high school students.

One week after this High School Conference meeting, the North Central Association held its meeting in Chicago and among other things, appointed a committee of seven with Dr. E. R. Downing as its chairman, and called the Committee on Reorganization. Later, the following resolutions were adopted for the guidance of this committee on reorganization:

1. Instruction in science for the first two high school years should be such as to put the child in an understanding and appreciation of his environment, that he may become a better social being and better citizen.

2. That this instruction should be such as will contribute to the further development of any science he may choose to pursue.

3. These aims and principles should be incorporated within the material content of the course in general or fundamental science.

Now, you may be asking, why I can say that the adoption of these two sets of resolutions and the appointment of these two committees means the end of the war over general science. First of all, this is because both of these meetings were pervaded by a splendid spirit of compromise and a seeking for common ground, and second because so much common ground was revealed in the discussions of the two meetings.

It is clear now, for example, that general science is not a new science; it is not a different subject matter, necessarily; it is merely a different method. It is a method which seeks to place the emphasis on application, to appeal to a child's native interests, and to present the work in problem form as much as possible. These are things which have been too much neglected in some science teaching. The main common ground, however, which these meetings brought out, is found in the fact that all of us seem to be convinced and united in the belief that the

first two years of science study in the high school should be devoted to a mastery of such fundamental principles and facts of science as are likely to have the largest possible practical social outcomes in the lives and citizenship of those we teach. It is not a matter of such great moment, whether we teach this science by the general science method, the project method, the special science method, or some admixture of these various methods; the matter of common concern, is that we select, organize and teach by some method, the kind of science that would be of most social value, should it become generally known, among high school graduates.

Now, I know that it would be a perfectly fine thing if every high school student could spend a year or even two years in the study of botany or chemistry, or geography, but it would be a deplorable thing if he had to remain forever ignorant of all other science in order to do this. At present, there are six fundamental sciences competing with each other for space in the high school curriculum, namely: botany, zoology, physiology, physical geography, physics, and chemistry. It is absolutely impossible that every high school student should be expected to study each of these sciences, even if they should be offered in half-year courses. I take it as self-evident, too, that each of these six sciences contains something which ought to be a part of the common pabulum of science knowledge possessed by high school graduates. Consequently, I believe that the best thing to be done is to select from these six, and possibly from other sources, the facts and principles which are most worthy, because of their direct social outcomes, to be made common knowledge among the future citizens who are now passing thru the high schools, and then teach this science to all these people, by the best methods that we can devise. You may be asking: Am I overvaluing the knowledge side and forgetting training in the scientific method and the scientific attitude of mind? That is a matter of method, and not so much a matter of subject matter. The science that is socially most valuable, is just as good for training as any other kind of science.

By deliberately selecting a common pabulum of science and seeking to teach it to every one who stays in high school long enough to learn it, we shall greatly increase the

potency for good what science is taught. This general knowledge will become a common medium for the exchange of ideas; it will naturally lead to community of action and it will function in community life, just because it is common knowledge, in a manner that the heterogeneous training in science that we are giving today cannot.

It may be said that we can not determine accurately at once what science is most valuable. This is true, but we can make a pretty good guess at it, and we must make the best guess we can, until future scientific studies of the problem gives us better guidance.

THE USE OF CENTRAL DISTRICT COALS IN WATER-GAS MANUFACTURE

W. A. Dunkley, Illinois Geological Survey.

An extensive investigation of coal and coal mining has been in progress since 1911 under a cooperative agreement between the U. S. Bureau of Mines, the Illinois State Geological Survey, and the Engineering Experiment Station of the University of Illinois. The particular phase of this investigation which will be discussed in this paper is the use of coals of the central district, including Illinois, Indiana, and Western Kentucky, in the manufacture of carburetted water-gas. In discussing this topic it is not the intention to go as extensively into the details of operation as would be done in a paper addressed primarily to the gas operator, but rather to treat the subject in a more general manner and point out its bearing upon the development of the coal resources of this region and upon the gas industry.

The production of manufactured gas in the State of Illinois alone amounts to approximately thirty billion cubic feet per year. Of this amount about one-third is coal gas made by the distillation of coal in retorts or coke ovens, and about two-thirds is carburetted water-gas. To make this amount of gas the amount of fuel required is roughly about one million tons of gas coal, 350,000 tons of coke or its equivalent, and 65 million gallons of gas oil, in addition to the fuel required to operate the steam power plant which is a necessary adjunct to every gas plant. It will be seen, therefore, that the gas industry is a fairly large user of fuel, and it may also be stated that it is a particular user. To be suitable for gas manufacture, whether coal-gas or water-gas, the fuel must comply with certain standards which are fairly well defined, and which narrow the selection very greatly. While in the present case we are chiefly concerned in the water-gas process, it may be said that coke produced as a by-product in retort and oven coal-gas

manufacture has been heretofore the chief generator fuel used in water-gas manufacture, and therefore the requirements of the water-gas process have had an important bearing on the selection of coal for coal-gas manufacture.

To be suitable for use in water-gas making, a fuel, whether coke or coal, must have fairly good physical strength, so that it will stand transportation and will not break up too much in the generator. It must be low in sulphur, since usually at least one-fourth of the sulphur is transmitted to the gas made. When burned in the water-gas generator, it must not produce a clinker which is too difficult to handle or which obstructs the passage of air too much within a reasonable operating time, nor should the amount of clinker be excessive; therefore the ash content of the fuel should be as low as possible.

These specifications as to fuel quality, both for coal-gas and water-gas manufacture, have heretofore narrowed the production of coal for these purposes to certain rather limited areas. Among these the most notable ones in the eastern part of the United States are the Pittsburgh district and certain areas in West Virginia and eastern Kentucky. The enormous growth of the steel industry which uses roughly one ton of coke for every ton of pig iron produced, and the steady growth of the gas industry, even in the face of electrical competition have drawn heavily upon the resources of the best coking coals, and already the necessity is felt for using coals from other regions which even if somewhat inferior to those from the localities just named are at least usable without too radical changes in the gas-making methods and equipment now in use.

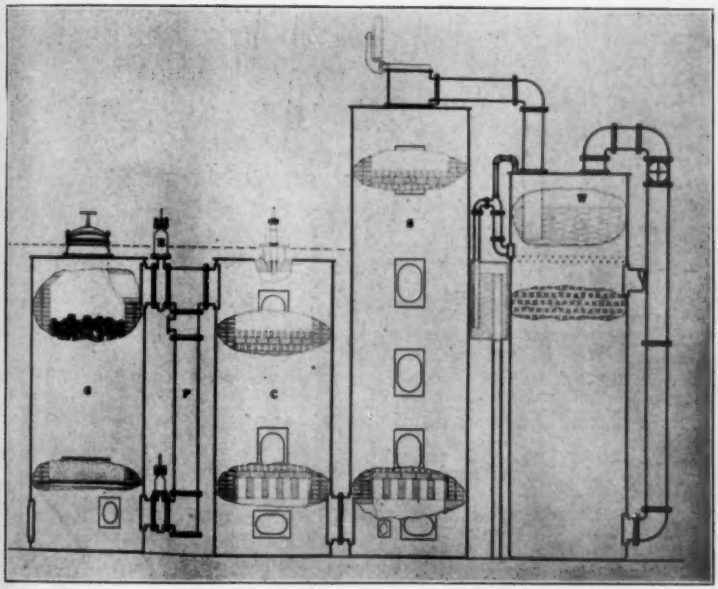
The State of Illinois has enormous bituminous coal resources, estimated at about 200 billion tons. This is one-third more than West Virginia, nearly twice as much as Pennsylvania, and more than twice as much as Ohio. Of this enormous amount of coal, very little if any fulfills completely the rigid requirements of the gas and cooking industry.

In general, it may be said that most of the central district coals, under present operating methods, produce a softer, more fragile coke, and about 20 per cent less gas per ton than the best eastern gas coals and while the by-product yield is good, most of the central district coals

contain considerably more than 1 per cent of sulphur, which was formerly regarded as the upper limit for gas coals. As water-gas generator fuel, the coke from central district coals does not usually produce as large a volume of gas in a given time as some eastern cokes and the ash frequently fuses to a clinker which is very obstinate to handle. With present methods, therefore, only a few restricted areas produce coal which is considered usable. Nevertheless, even these restricted areas are capable of producing much more than sufficient tonnage of coal to meet the gas-making needs of this region.

The production of central district coal for gas making was greatly stimulated by the war. Transportation difficulties and the zoning system of the Fuel Administration made fuel supply conditions very critical for the gas industry of this region. Many gas companies found it not only impossible to obtain eastern coal for coal-gas manufacture, but were even unable to obtain any kind of coke at all for water-gas making. Their only resort was to turn to raw bituminous coal, a fuel which though it had been tried by some enterprising water-gas makers at various times, had never been used with any marked success, on account of many difficulties attending its use. With necessity as a spur, however, many gas operators accomplished wonders. They not only kept their plants in operation but were able to realize economies which made the use of bituminous fuel financially attractive under prevailing price conditions, even when other fuels became obtainable again. It is the purpose of this paper to discuss some of the problems encountered and their solutions.

For the benefit of those who may not be familiar with the water-gas process, a brief description may not be out of place. The accompanying diagram illustrates the usual arrangement of parts of the apparatus, though there are some machines which are different in design though similar in principle. The machine consists of three principal chambers, the generator, carburetor, and superheater, marked G. C. and S., respectively. In general these chambers consist of cylindrical shells of heavy steel plate lined with refractory blocks. The generator is the heart of the gas machine. In it is a deep bed of fuel resting on a grate and filling the generator nearly to the take-off connection.



Below the grate is a connection by which air is admitted from a high-speed blower during the blasting portion of the operation. The air soon brings the fuel bed to a high state of incandescence. During this blowing period the air gas formed, which contains a considerable percentage of carbon monoxide, is burned by a secondary air blast in the carburetor and superheater, and some of the heat is stored in the piles of staggered brick checkerwork with which these chambers are filled. The combustion products pass through the open stack valve into the air. When the fuel bed and the checkerwork have attained the proper temperature, the blowing is discontinued, the stack valve is closed, and steam is then blown through the incandescent fuel bed.

The steam reacts with the carbon of the fuel, forming carbon dioxide, carbon monoxide, and hydrogen. The carbon dioxide content of the gases leaving the generator is at first low, but increases as the fuel bed cools. Since this constituent is of course undesirable, the steaming process is interrupted so soon as it becomes unduly prominent, and the fire is again blasted with air. The gas produced during the steaming, or run period as it is called, usually has a heating value of about 300 B. t. u. per cubic foot. Since most states require a heating value in the finished gas of at least 565 B. t. u., as in Illinois, it is necessary to enrich this "blue" gas, as it is designated, by gas men. This is accomplished by spraying oil onto the hot bricks in the carburetor. The oil is broken up into vapor which mixes with the "blue" water-gas, and this vapor by further contact with the hot bricks in the superheater, becomes largely fixed as a permanent gas which will not condense back into oil when cooled. The carburetted gas passes through the water seal of the wash box, W, and thence through further apparatus where it is cooled, cleaned, and purified before being distributed to the consumers.

It is not to be assumed that the operation is so simple in practice as just described. The blowing and steaming periods have to be regulated with great care, not only as to duration, but also in respect to the amount of air, steam, and oil admitted. A small fraction of a minute added to or subtracted from one of these periods has marked effects on the temperature balance of the machine and nearly all modern gas sets are equipped with steam, air, and oil

meters and with pyrometers to show temperatures in the fixing chambers, and the gas maker times the operation with a clock equipped with a second hand. The steaming and blowing periods are different in different plants. While an infinitesimally short blow, followed by an infinitesimally short run would probably be the ideal arrangement or cycle, the time required to operate valves makes extremely short periods impracticable. In practice we find blow periods from 2 to 4 minutes and run periods from 3 to 6 minutes or possibly even longer in some cases. During the blast period the air always passes upward through the fire, but in modern practice a portion of the steam runs are made down through the fuel, the gas passing to the carburetor through the refractory lined pipe, P. This reversal not only protects the hot valve, H, from becoming overheated, but also puts the fire in better condition for gas making. The lid on the top of the generator is opened at intervals of perhaps five or six runs to introduce a fresh charge of fuel. At intervals of perhaps 8 to 10 hours, depending upon the fuel, operation has to be discontinued and the accumulated ashes and clinkers removed through the lower doors. This procedure, which may require anywhere from a few minutes to four or five hours, of course shortens the actual operating time and may cause the rejection of a particular fuel, which otherwise might be considered suitable, and frequently much experimenting is done to find a set of operating conditions which will make practical the use of a particular fuel which, though otherwise good, gives an obstinate clinker. It is remarkable what can sometimes be accomplished by slightly modifying the amount or duration of the blowing or steaming, or by changing the percentage of up and down steam runs.

Coke or anthracite coal, since they contain very little volatile matter, could, except for the complications sometimes introduced by the nature of the ash formed, be considered as pure carbon. With bituminous coals, however, the gas maker is confronted by new problems. The coals of the central district usually contain from 35 to 45 per cent of volatile matter, and exhibit the property of caking when heated. The volatile matter of the coal consists not only of water vapor and permanent gases, but also of heavy condensible vapors which upon cooling form tar.

The volatile matter and the caking property are the chief factors which make the use of bituminous coal for this purpose, a problem of many difficulties. To follow exactly the same methods as employed with coke or anthracite would be to court failure from the start. Among the difficulties usually encountered may be mentioned, the production of great volumes of smoke, a marked decrease in gas production capacity, and the rapid plugging of the brick checkerwork with pitch and soot. To overcome these difficulties a vast amount of experimenting has been done by various gas operators. While there has been some exchange of views among the operators, it was found on an inspection tour made last summer, by Mr. W. W. Odell, gas engineer of the U. S. Bureau of Mines, and the writer, that many operators were beset by so many difficulties connected with securing labor and materials and maintaining their plants that they had little time to devote to the solution of actual machine operating difficulties. As a result of the inspection, the Geological Survey published its Cooperative Mining Investigations Bulletin No. 22, describing the observed practice in operating with bituminous coals up to that time and it was decided to make an investigation on a practical scale to learn more facts if possible for dissemination to the gas industry. The Public Service Company of Northern Illinois very generously offered the facilities of the Streator plant for the experiments. Mr. Odell and the writer spent several weeks in that plant, experimenting with various coals under different conditions. While there are still some difficulties to be overcome, it is felt that the results obtained there and the application of the methods employed to some other plants have justified the time and money spent and have demonstrated that many of the difficulties formerly encountered can be entirely overcome or greatly diminished. In discussing the methods used at Streator, no attempt will be made to go into great detail. The main facts will be mainly outlined. It is not claimed that all the methods tried originated in the Streator tests. Some of them had been worked out by other operators and to them great credit is due for the pioneer work accomplished.

One of the first difficulties to be overcome in the use of bituminous coal was the obstruction to the passage of air blast and steam caused by the caking of the coal. With

coke or anthracite it is often customary to make fuel charges of perhaps 700 or 800 pounds at a time in a 6 ft. set and after cleaning the fire it is often the practice to make double or even triple charges to build the fuel bed rapidly up to the proper operating depth. If this procedure is followed with bituminous coal, within an hour or so the caking of the coal has progressed to such an extent that an arch of partially caked fuel, almost impenetrable to the air blast, is formed. The result is that the rate of combustion is greatly slackened, the fuel bed becomes relatively cold, and the gas-making reactions of the steam run are also slackened. Under these conditions the rate of production falls far below that ordinarily obtainable with coke. The only remedy for this condition after it has taken place is to break up the caked fuel frequently, with heavy iron bars, a laborious time-consuming operation. The remedy applied at Streator and elsewhere was to avoid all double fuel charges and rather make the charges lighter and more frequent at the start until the fuel had been brought up to working depth. By this procedure barring the fire could be entirely avoided. While the rate of gas production was increased, it did not equal the production with coke, and a method developed at Streator for increasing production will be discussed a little later.

The smoke problem was also one which caused much concern to the gas operator, but especially to other establishments located in proximity to the gas plant. Water-gas sets do not usually have high stacks which dissipate smoke in the upper atmosphere. The combustion products are usually expelled just above roof level; consequently near neighbors get the full benefit when smoke is produced. The greatest difficulty was experienced after the machine had been idle for several hours and the fuel bed and checkerwork had cooled somewhat. If a charge of fresh coal were added to the fire and the blast commenced, the blast gas produced in the generator at first would not be rich enough to burn upon the addition of secondary air, or if it were the temperature of the checkerwork might be too low to ignite it. As a result, the tar vapors formed from incomplete combustion of the coal would pass through the carburetor and superheater unconsumed, and even the pilot light kept constantly burning at the stack would only partially ignite them if at all. The result was

a dense cloud of yellow or brown smoke. After the fuel bed and checkerwork were well heated, little more trouble from this source would be encountered. A remedy which was developed at Streator worked out quite successfully, was to make a fresh charge of fuel just before shutting down the set and making only one or two runs from it. During the succeeding lay-over period this coal coked gradually and by the time the set was again put into operation it had become completely coked. Then upon blasting the machine could be brought rapidly up to temperature, and after one or two runs had been made, the addition of fresh fuel produced very little if any smoke, since the tarry vapors could be ignited and completely consumed.

As has been previously explained, the blow and run periods are so timed as to bring all three chambers to the proper operating temperatures at the same time. Since the caking property of the coal tends to make the fuel bed more resistant to the passage of air than coke fuel, it is evident that with a given air-blast pressure available, it will take a longer blowing time to get the coal fuel to the proper temperature. However, since there is considerable rich volatile matter given off from coal, this upon burning in the carburetor and superheater tends to overheat these chambers before the generator is hot enough. Since the temperature most favorable for properly fixing the gas oil is quite well defined, excess temperature tends to break up the oil too much with the formation of lamp-black which rapidly fouls the checkerwork and chokes the connections. If a great part of the combustible gas is burned outside the machine at the stack, the latter becomes overheated, and at any rate fuel is wasted. Several methods for remedying this condition have been tried, but practically all of them result in a great deal smaller production of gas in a given time than is possible with coke, the reduction amounting to as much as 30 per cent. A method was worked out at Streator which obviates this difficulty and at the same time increases capacity, and this method will be briefly described.

The gas produced during the blow period becomes momentarily greater in heating value as the blow proceeds, due to the increasing percentage of carbon monoxide. At the end of a three-minute blow, for example, it may have a

heating value of perhaps 155 B. t. u. per cubic feet with coal fuel, due to the presence of carbon monoxide and hydrocarbons. It was concluded that a certain amount of this gas was worth saving and as the carburetor and superheater had usually attained a suitable temperature of 1350 to 1400 degrees F., by this time, the stack valve was closed and the blast continued for 15 to 30 seconds, no secondary air being admitted during this time. The term "blow-run" was coined for this part of the operation since it was a run with blast instead of steam. This additional blasting time improved the generator condition and since the gas was not burned in the carburetor and superheater, these chambers were not overheated by this additional blast. A volume of gas equal to 20 to 30 per cent of the usual volume was added to the production and while the amount of oil required to enrich this relatively poorer gas was somewhat greater, it did not equal that usually required with coke. The amount of generator fuel consumed per unit of gas volume materially decreased.

While this method is not claimed to be a panacea for all the troubles experienced in using bituminous coal in water-gas making, it worked successfully at Streator and has been applied with more or less success at other plants according to the extent to which the particular conditions are favorable to it. It is hoped that the investigation of its application may be continued farther.

The choice of a generator fuel for gas making is an economic matter depending upon the cost of the fuel and the efficiency with which it can be used. Assuming that a given fuel is usable and will produce the amount of gas required, the question which must always be answered is, what will be the relative cost of making 1000 cubic feet of gas with various fuels. Not only cost per ton and the actual amount of fuel consumed enter into the problem but also the effect on the amount of oil required to enrich the gas and the cost of other materials and of labor occasioned by its use. These costs will not be the same for a particular fuel in different plants, even if the actual cost of generator fuel is the same. To take a particular case and assume certain costs for materials and labor is always likely to lead to erroneous or misleading conclusions for there are always those who are sure to take assumed

figures as statements of fact. In comparing coal and coke as water-gas generator fuels, it may be said, however, that with the difference in price in these fuels which has prevailed, many operators who were so equipped that they could maintain their gas production with coal have realized a very substantial saving from its use.

While during the earlier experimental stages a very large percentage of the heat in the coal was wasted in smoke and otherwise, some operators have now perfected their operation so that nearly if not quite as much of the heat in the coal is now utilized in the finished gas as when coke was used. The volatile matter of the coal also assists to a certain extent in enriching the gas. The gases leaving the generator when coal is used are richer than "blue" gas from coke, and consequently less oil is required to enrich the gas to a given quality. The saving in oil frequently amounts to a third of a gallon per 1,000 cubic feet of finished gas. The relative labor, repair, and purification costs with the two fuels depend upon the particular coal or coke used, the capacity obtained and the operating difficulties encountered. While these costs are in some cases slightly greater with coal than with coke, the difference is relatively unimportant. In general, it may be said that even with normal prices of materials and labor, coal as generator fuel shows a distinct economical advantage where it can be used, and its use can be greatly extended.

Aside from the gas operator point of view, this subject has a significance to the general public. Any saving effected by the gas companies in operation will in time be reflected in the quality of service rendered to the public. In some cases the use of coal in place of coke will either result in lower rates or will enable the gas companies to continue operation without increasing rates. Every ton of coal substituted for coke in this process releases a certain amount of coke for domestic use, and if coke were used more for domestic purposes in place of bituminous coal the atmosphere and surroundings would be distinctly brighter. Further a saving of a few tenths of a gallon of gas oil in the manufacture of a thousand cubic feet of gas would in the aggregate amount to several millions of gallons a year in this State alone, could such a saving be realized by all companies. The saving of long freight hauls of coke from

eastern plants or of eastern coal to produce this amount of coke would be no small item of national economy. In addition to these factors, the use of central district coals for water-gas is one more step in the development of the great coal resources of this region, especially those of Illinois.

THE ILLINOIS PYRITE INVENTORY NATIONAL SULPHUR SITUATION IN THE SPRING OF 1918

G. H. Cady, Illinois Geological Survey, Urbana.

With the entrance of the United States into the war and with the reduction in the importation of Spanish pyrite that followed, the increased requirements of raw material from domestic sources for use in the manufacture of sulphuric acid became a matter of some concern. Considerable tension developed over the situation in some quarters. The production of sulphuric acid (monohydrate) in 1917 was about 4,300,000 tons, against about 3,900,000 tons in 1916. We imported from Spain and Portugal in 1917 about 833,000 tons of pyrite which may be reckoned as equivalent of about 1,000,000 tons of sulphuric acid (monohydrate); so that from domestic and Canadian resources we manufactured in 1917 about 3,300,000 tons of sulphuric acid. The government estimated a requirement of 5,000,000 to 5,600,000 tons in 1918. It appeared necessary, therefore, to find raw material in 1918 sufficient to manufacture about 2,300,000 additional tons of acid.

A careful review of the possible sources of raw material by government agencies revealed what seemed early in 1918 to be incapacity of the then existing sources to meet the probable demand. Sulphuric acid is manufactured from three sorts of material:—native sulphur or brimstone, pyrites, and as a by-product in smelting and refining. In 1917 brimstone used in the manufacture of sulphuric acid amounted to 463,364 tons producing possibly about 1,300,000 tons of acid (monohydrate); in the same year 1,257,128 tons of pyrite produced about 2,000,000 tons of acid; and by-product acid to the amount of about 1,000,000 tons was manufactured, mainly in the western states—a total, as has been stated, of about 4,300,000 tons. With about 800,000 tons of Spanish pyrite cut off the market and a probable additional demand for raw material

necessary to manufacture about 1,300,000 tons of acid, there was an apparent need for the stimulation of the industry and the discovery of additional sources of raw material. It was also obvious that because of the high freight rates from the western smelters, the acid industry would have to depend upon the brimstone and pyrite producers for the additional amounts of raw material necessary to carry on the industry.

Naturally the acid manufacturers, when the importations of Spanish pyrite were restricted, turned to the most readily available source of supply—the sulphur or brimstone deposits of Louisiana and Texas. These are located respectively at Sulphur, Louisiana, and Bryan Heights, Texas. Among those agencies interested in determining the resources available for the continuation of the war activities at the scale required, it became a matter of doubt whether the Texas and Louisiana deposits were going to be anywhere nearly adequate to meet the needs. The amount of sulphur necessary to manufacture the postulated additional 2,300,000 tons of acid that must be produced from domestic resources was about 1,200,000 tons. As the amount of brimstone used the preceding year was less than 500,000 tons, and as the wells were supposed to be producing about up to their capacity, it was thought quite impossible for the two companies to produce the necessary requirements of brimstone to meet the acid manufacturers' needs. Unfortunately, actual statistics of the sulphur produced in 191' are not available, so that it is possible that the amount of brimstone used was actually less than that produced.

In view of what was interpreted to be an impending shortage of brimstone the pyrite resources became a matter of investigation. Pyrite in the central and eastern states was of especial interest because of its nearness to the acid plants. In this part of the country it occurs as "coal brasses" in coal mines and as mineral deposits in certain states such as Missouri, Virginia, Georgia, and Wisconsin. Under the influence of interest stimulated by war committees, such as the War Minerals Committee, the U. S. Bureau of Mines in cooperation with the geological surveys of several states, instituted an extensive inventory

of the pyrite resources of the central and eastern states. The coal-producing states were given special attention, because of the recognized importance of the coal mines as the most probable source of large quantities of pyrite.

As a result of this investigation carried on in the coal fields under the direction of Mr. E. A. Holbrook of the U. S. Bureau of Mines, it is now known that the coal mines of Pennsylvania, Ohio, Kentucky, Indiana, Michigan, Illinois, and Missouri can easily furnish, with the equipment now available, up to more than 2,000,000 tons of pyrite annually, and that the mines of Illinois, on a very conservative estimate, could easily produce 200,000 tons without additional equipment. During 1917 this State produced about 24,000 tons, so that it is probably producing not over one-tenth of what it could easily produce. Indeed, with additional rather inepensive equipment, the output could be increased very materially beyond 200,000 tons, probably nearly 500,000 tons annually, a figure which is essentially the amount of pre-war demand for pyrite from domestic sources.

That the stimulation of the pyrite industry has not resulted from the growth of war industries has been somewhat of a surprise. Events have shown, however, that the country possesses larger resources of brimstone than could have been suspected at the time the pyrite inventory was inaugurated. New areas have been opened to development, and new wells have been drilled on the original properties, so that at the opening of 1919, it is a serious problem to find a market for the prospective production of brimstone. In fact, as early as July, the War Industries Board issued the statement that there was above ground at the mines in Louisiana and Texas, over 1,000,000 tons of brimstone—a sufficient stock for 8 months at the rate of 120,000 tons a month, which was approximately the current demand, according to one authority. There was the additional uncertainty, however, in regard to these deposits that was occasioned by their location near the coast, thereby making them possible targets of marauding German vessels that might escape into the Gulf. In general, however, uneasiness in regard to a possible sulphuric acid shortage had disappeared in the latter part of the summer, before the pyrite inventory had been completed in all the states.

Pyrite Situation in Illinois.

The pyrite inventory in Illinois, as well as in the other states, can most properly be looked upon as insurance against a possible contingency. Yet so far as Illinois is concerned, it will possibly lead to some benefits to the coal trade on a peace basis.

It has been shown that pyrite can be recovered at washeries at a very small expense. The expense involves the installation and operation of one or two more jigs where the refuse is washed, to recover the pyrite, the refuse itself being furnished without cost as a product of the coal washery. At least one coal washery has installed a pyrite-recovery section during the last year. Others would probably find it profitable to do the same.

The pyrite inventory has also furnished a more systematic body of information relative to the distribution and occurrence of the pyrite than heretofore has existed. The investigations of the resources and the search for low-sulphur coal in connection with the work on gas coals performed by the Gas Section of the Illinois Mining Investigations have together furnished information relative to the distribution of sulphur and pyrite that is doubtless of sufficient general interest to warrant brief comment.

The accompanying map shows the Illinois coal basin surrounded by a red border. It shows also in colors the areas wherein the various coals are mined. Thus, in the pink areas No. 2 coal is mined; in the green, No. 1; in the yeellow, No. 5; in the blue, No. 6; and in the brown, No. 7. The bright yellow area with a reddish area within it, in the southern part of the State, has no reference to the number of the coal. It lies within the area in which No. 6 coal is mined.

The actual sulphur content of the coals of the State, as determined by analyses of face samples, differs in a conspicuous degree only as between coals of southern Illinois and coals of central and northern Illinois. Small black figures on the map show the average sulphur content of the coal at about 100 representative mines, as determined by 3 or more analyses of face samples at each mine. There

is possibly a variation of about 1 per cent in the sulphur content among the coals north of Jackson, Jefferson, and Saline counties, except for Mercer and Rock Island counties. These coals have between 3.25 and 4.00 per cent of sulphur. The Rock Island and Mercer County coal (No. 1) has an unusual sulphur content, varying from 4.25 to 5.02 per cent.

In the southern counties, Jackson, Williamson, southeastern Perry, Saline, and Gallatin, the sulphur content averages 1 to 2 per cent less than it does to the north, varying from about 1 to 2.75 per cent. In the yellow area, shown on the map in Franklin, Williamson, and Jackson counties, the sulphur content averages below 1.5 per cent, and in the pink area within the yellow, below 1 per cent. The low sulphur content of the southern Illinois coals is one special reason for their greater desirability among the coals of the State for domestic as well as for gas-making purposes. It should be stated, however, that coal from other parts of the State, if properly prepared at the mine, could probably be used with equal satisfaction by the householder, thus reserving the low-sulphur coal for industrial uses, to which it is specifically adapted.

In general, the low-sulphur coals containing less than three per cent of sulphur do not contain much pyrite in free or nodular form. Very little recoverable pyrite is present in these coals. The higher sulphur coals, however, although they all contain free pyrite in some form, do not always contain it in recoverable form. Its ease of recovery may in fact be taken as an index of the ease with which clean coal can be furnished at the shaft head. The ease of recovery, furthermore, can by no means be inferred from the coal analysis, but can be determined only by an inspection of the coal at the face in the mine.

Most of the pyrite occurs in one of three forms: (1) as nodules or balls; (2) as sheets or thin lenses in the parting between benches; and (3) as lenticular masses fingering laterally into the coal. Coals differ somewhat characteristically in regard to the form of pyrite most commonly found in each bed. Thus, No. 2 coal of northern Illinois

has free pyrite most commonly in the form of nodules of brassy, mettalic-like, massive sulphide. No. 5 coal in the Peoria-Springfield district has pyrite balls of the same sort in the upper coal, but more characteristic is what is known as the brown or gray sulphur lenses. These are lenticular or irregular masses of banded stony pyrite that finger laterally into the coal. No. 6 coals is distinctly a bedded coal, separated into three or more persistent benches. The pyrite is most commonly found as plates or thin lenses in the parting between the benches. No.7 coal carries a large amount of pyrite as irregular lenses of massive stony sulphide much like that found in No. 5 coal, but not commonly banded.

Pyrite can be recovered in two places: at the coal face by the miner and loader, and at the tipple by pickers, by mechanical dry separation, and by washing the coal. The latter method is probably the most efficient, but the coal should also be picked at the face to remove the large pyrite nodules, if the pyrite is to be marketed.

The ease of recoverability of the different forms of pyrite varies. The more easily the pyrite can be recovered the cleaner the coal that can be produced without special facilities for treatment at the tipple. Large nodules of bright pyrite such as are found in No. 2 coal are easily seen by the miner, and relatively easiery removed. Irregular lenticular masses "frozen" to the coal, such as are found in No. 5 and No. 7 coals, are not readily removed, and the miner is too inclined to throw chunks of coal containing such lenses into the car, risking possible discovery at the tipple, and the resulting fine. Too frequently this is a very slight risk. Sheet pyrite is easily hand-picked when thick enough to resist the shattering incident to mining. When thin, however, it breaks into small pieces and forms accordingly a considerable part of the fine coal or screenings and can only be removed by mechanical separation of some sort.

If pyrite is to be considered as an impurity to be discarded rather than a commodity to be saved, as apparently it must continue to be regarded until its recovery becomes a matter of economic importance, the investigations have indicated that more systematic efforts than have been in

force in the past should be instituted to eliminate this material from the coal before it is furnished to the public. Certainly the material has not been removed from the coal nearly as effectively as it might be, nor possibly have the means adopted in individual cases been especially applicable to the form of pyrite present. Some blame attaches to the miner for not obeying the rules and to the operator for not enforcing the rules in regard to clean coal. But a large part of the blame attaches to the general public in not insisting that all coal be subjected to some adequate form of preparation at the tipple. It is a glaring economic sin to use an unmanufactured product such as raw coal when with a little foresight we might be getting several times the return now obtained. The first step in repentance should be an insistence that all operators properly prepare their coal for the trade.

In summary: The pyrite inventory in Illinois has served its immediate purpose of furnishing the nation definite data concerning its supply of one of the essential war minerals. Aside from furnishing desired information along the original lines of the investigation, the pyrite inventory has some economic bearing upon the industry in the normal times of peace. In connection with search for low-sulphur coal, it has effected a definite delineation of areas of coal suitable for special purposes, such as the manufacture of metallurgical coke and city gas. It has also furnished information relative to the varieties of free pyrite found in the higher sulphur coals which possibly may lead to a better understanding of the various conditions affecting the production of clean coal at the shaft head. This information is preliminary to a more systematic adaptation of the means of cleaning coal to the varying conditions of occurrence of the impurities whose elimination is desired. The pyrite inventory was an investigation conducted to safeguard the public safety. It had uncertain commercial application and was of such a nature that private capital could only with difficulty have been found to carry it through. It is such services that can best be accomplished with public funds such as are allotted to the State Geological Survey.

Papers on Botany

SOIL AS A LIMITING FACTOR OF FORESTS IN LA SALLE COUNTY, ILLINOIS

GEORGE D. FULLER, THE UNIVERSITY OF CHICAGO.

La Salle County, Illinois, is situated in the north-central part of the state within what is usually termed the "corn belt" on account of the extensive culture of that crop on the dark brown or black soils of the prairie. It is also within the region of the early Wisconsin glaciation, the Bloomington moraine skirting its northern boundary. The surface is gently rolling, the highest altitude at the northwest corner being 930 feet from which the plain slopes gradually to about 630 feet at the edge of the Illinois River valley. This valley, intersecting the county from east to west, lies about 200 feet below the level of the adjacent uplands. On account of the peculiar distribution of forests in this prairie county it was selected in the autumn of 1918 as one of the areas to be included in a State Forestry Survey. It seemed probable that it might present problems involving the factors which determine the relative extent of grassland and woodland in the State of Illinois.

This is not an opportune time to present the different theories as to the causes of the development of a grassland vegetation. These have been well summarized by Shimek[1], who has also given in the same report an excellent bibliography of the earlier American literature upon the subject. Gleason[2] has stated some of the unsolved problems of the prairies and Cowles[3] has pointed out that the causes which explain the prairie vegetation of Illinois must not be applied, in all cases, to the great climatic prairies of the farther west.

[1] Shimek, B. The prairies. Bull. Lab. Nat. Hist. State Univ. Iowa 6: 169-240. plates 13. map. 1911.

[2] Gleason, H. A. Some unsolved problems of the prairies. Bull. Torr. Bot. Club 36: 265-271.

[3] Cowles, H. C. The physiographic ecology of Chicago and vicinity. Bot. Gaz. 31: 73-108, 145-182. figs. 35. 1901.

In the course of our forest survey certain relations in the distribution of soil types and native vegetation have impressed themselves upon the writer as affording some elucidation of one phase, at least, of the problem of the relative limits of the distribution of forests and grasslands in a portion of Illinois which lies in the tension zone of the great forest and grassland formations of this continent.

In the portion of the county covered in this survey the surface soil is dark brown in color and in a soil survey[4] is referred to as an upland prairie soil known as the "brown silt loam." It is described as composed largely of wind-blown loessial material to a depth of three to five feet the upper 6 or 8 inches having a humus content of about 6%. In depressions where drainage is poor a black silt loam is found. These together cover 80% of the entire area of the county.

In these soils streams are cutting their channels and developing their valleys. In the northern part of the county the cutting is slight and little or no valley has been developed, but as the Fox and Illinois Rivers are approached the tributary streams are found to be from 50 to 80 feet below the upland. As these streams have developed shallow valleys have been formed, portions of the surface silt loam being removed to depths varying from a few inches to several feet. As the usual depth of the prairie silt loam is about three feet it is clear that along the streams that have eroded definite valleys there will be exposed a strip of the soil immediately below that covering the upland. This soil naturally varies somewhat from that which overlaid it and this variation is manifest in differences of color and texture, and what is probable of much greater ecological significance, in slope and drainage. This difference in topography doubtlessly affects in a very material way the water content of the soil at various seasons of the year and these differences of soil moisture will naturally react upon the vegetation.

The Department of Soil Survey of the State Agricultural Experiment Station in making a soil survey of the county has recognized the differences between the upland prairie silt loams and the soil of slightly lower

[4] Hopkins, Cyril G., et al. La Salle County soils. Soil Report No. 5, Univ. Ill. Agr. Exper. Station. pp. 45. maps. 1913.

level bordering the streams, the latter being designated "yellow-grey silt loam." Aside from differences of color and water content it contains less of the finer wind blown material and has a lower humus content. The excellent maps accompanying the report of the Soil Survey, published in 1913, show the larger streams bordered by a narrower or broader band of this yellow-grey silt loam soil. Two or three of the streams flowing through the townships covered during the autumn of 1918 in our Forest Survey may be taken as examples of this soil distribution. Along the Little Vermilion in Troy Grove and Dimmick Townships the bordering strip of yellow-grey silt loam varies in width up to a maximum of 1500 yards.

Along Big Indian Creek in Earle Township it reaches a width of over a mile, while along Little Indian Creek in Adams and Serena Townships at its widest part the stream valley as indicated by the soil difference is two miles across.

For some reason not as yet clearly understood the strip of yellow-grey silt loam is decidedly wider upon the east side of these streams than upon the west. At times this difference is not great but it frequently happens that three-fourths of the entire strip is upon the left bank of the creek. An examination of other north and south streams shows that they possess the same soil fringe with a similar unequal lateral distribution.

It has been suggested that since the prevailing winds are from the west the inequality of the soil strip must be connected with the action of such winds in causing more deposition of wind-carried soil on the west bank of the stream or more wind erosion upon the east side. Another attempted explanation is connected with the movement of prairie fires from west to east but the causes of the distribution of this soil in this peculiar way is not of immediate importance in the present discussion. It is sufficient to point out that the soil has been recognized as essentially different, in some particulars, from the upland brown silt loam and its extent has been mapped in La Salle and other counties in the published reports of soil surveys.

In making our forest survey of portions of La Salle County it was soon noted that with the exception of a very narrow fringe of such trees as black willow along the small

streams there were no indigenous trees upon the brown silt loam soil nor could any indications be discovered that at any time had there been any forest upon this type of soil. The characterization of the brown silt loam by the members of the Soil Survey as an upland *prairie* soil seemed thus perfectly accurate.

On the other hand although all the bits of upland forest in the northwest portion of this county were upon the yellow-grey silt loam much of this soil was under cultivation and all trace of tree growth had disappeared. There is, however, good reasons for believing that it was all originally forested and hence that it may appropriately bear the designation given it by the Soil Survey of "upland timber soil." The evidence of former forestation is briefly as follows: (1) A map made in 1819 purporting to show the original forest areas of the county; (2) The township maps showing that these areas of yellow-grey silt loam were in the early surveys cut up into lots of 5 to 20 acres and that these areas were held as wood lots by farmers having larger farms of prairie soil elsewhere in the county; (3) The testimony of the oldest inhabitants which seems to agree perfectly with soil distribution as charted; and (4) The remnants of forest remaining at the time of our survey which were scattered over all parts of the yellow-grey silt loam but were found nowhere upon the brown silt loam.

Therefore since the original distribution of upland forest in this portion of Illinois where the vegetation is predominatingly grassland is limited to a particular type of soil bordering the streams and somewhat below the level of the prairie upland, it seems fair to conclude that here, at least the character of the soil is the controling factor in deciding the limits of tree growth.

THE OCCURRENCE OF A WHITE FORM OF TRADESCANTIA VIRGINICA IN SOUTHERN ILLINOIS

CLARENCE BONNELL, HARRISBURG TOWNSHIP HIGH SCHOOL

For a number of years, students in the Harrisburg Township High School have studied Tradescantia Virginica as a type, also, on account of the interesting opportunity it affords of seeing circulating protoplasm within the cell. On several occasions, such students have told me that they had seen white specimens of the flower, but none were ever brought to my attention. During more than twelve years of rather careful study of the spring flora of Saline county, I had never come across such a specimen as had been described.

In April, 1917, Leonard Atkinson, a student in the school, found in a recently cleared field about two miles north of Harrisburg, Illinois, a group of Tradescantia with snow white flowers. He secured a herbarium specimen, brought another to the class room, and transferred another to his home yard. This transplanted specimen grew and bloomed again, and in profusion in the spring of 1918. It is, at present, growing and has spread sufficiently to be divided for further propagation and study.

A visit to the field where the first specimens were found in 1917, made a year later was disappointing, for the field had been plowed close up to the stump and no Tradescantia of any kind were to be found.

While I have not had access to authorities that mention white flowers in Tradescantia, I am informed that some authors do mention this feature using the expression, "rarely white." This matter has been of interest to us as an illustration of a very distinct variation from the type, whether it is to be called a distinct species, a mutation, or a more or less frequently recurring variation.

SOME FUNGI THAT ARE RARE OR HAVE NOT PREVIOUSLY BEEN REPORTED FROM ILLINOIS

W. B. McDOUGALL, UNIVERSITY OF ILLINOIS.

With two exceptions the mushrooms described below have not, to my knowledge, been previously reported from Illinois. The exceptions have only recently been reported by Mr. C. G. Lloyd, one of them as a new species, his report in each case being based on collections made by me. They are included here because they are of special interest.

My object in reporting these species at this time is twofold. In the first place, if I am not mistaken about their not having been reported from Illinois, they ought to be placed on record as occurring in this state. In the second place I have hopes that I may stimulate others to collect these larger fungi and especially to report what they have found. I am not myself so much interested in the systematic or taxonomic study of these mushrooms as in their distribution and ecology and what I have found has been the result of chance rather than of long hunting. But no one has ever collected the higher fungi extensively in this state and I am convinced that were a competent person to do so it would result in the discovery of a considerable number of undescribed species.

ASCOMYCETES

Bulgaria inquinans Fr. *(Fig. 1)*—This plant is not rare but is easily overlooked and is not often found in lists of collected fungi. It grows on partly decayed and usually partly buried oak sticks in woods. The larger specimens become 4.5 cm. broad and 3 cm. high. The receptacle is at first closed but soon opens, forming a cup, and may later become a nearly plane disk. The stem is short or sometimes entirely lacking. The plant is dark brown or almost black and rough or wrinkled on the outside. The disk of the cup is smooth and lighter colored. But the most striking characteristic of the plant is that it is very tough and

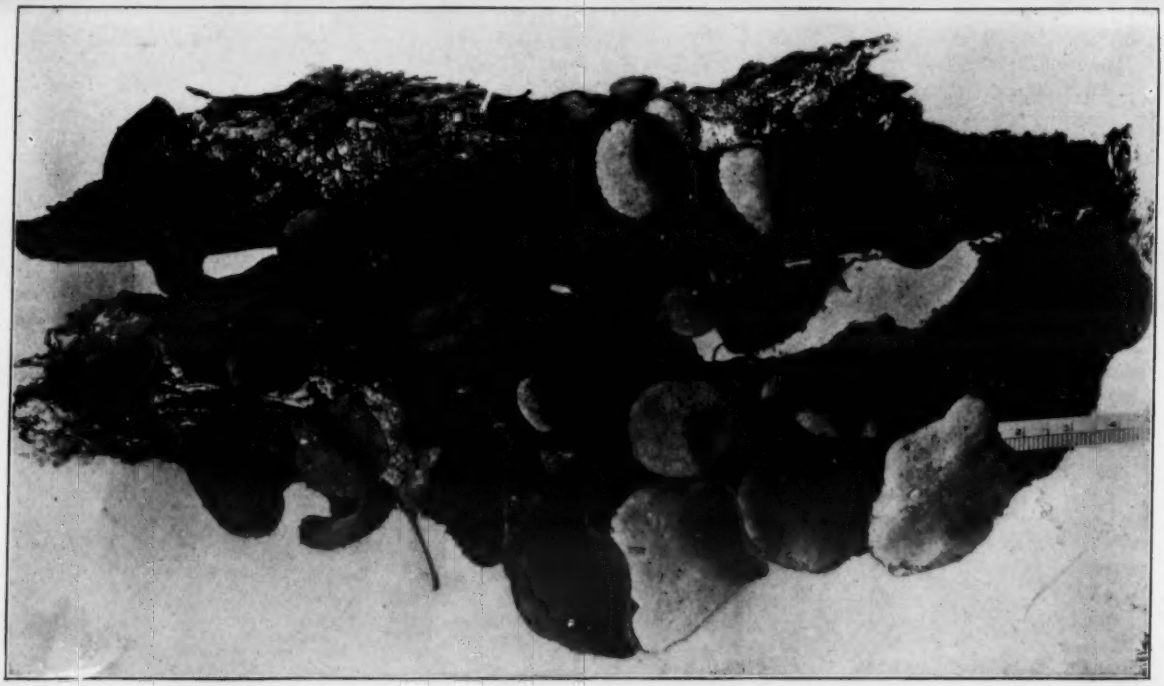


Fig. 1. Bulgaria inquinans

elastic and internally gelatinous. Its edibility so far as I know has not been tested but it does not look nor feel very inviting and is probably to be classed as non-poisonous but also non-edible. The specimens shown in the photograph were collected in a woods near Urbana.

Leotia lubrica Pers. *(Fig. 2)*—This plant like the preceding one is not at all rare and the only excuse for including it here is to put it on record as occurring in Illinois. It usually grows in clusters 5 to 8 cm. tall with the individual caps 1 to 3 cm. broad. The cap is irregularly hemispherical and usually somewhat wrinkled. The whole plant is of a peculiar yellowish green color. It is said to be edible but not of good quality. It grows in the woods often among mosses. The specimens photographed were found in the Forestry of the University of Illinois.

BASIDIOMYCETES

Craterellus cornucopioides Fr. *(Fig. 3)*—The "horn of plenty", as this plant is called is easily overlooked because of its blackish-brown color. It is trumpet-shaped, hollow to the base, and sometimes as much as 10 cm. high though more often not more than half that. It does not look very palatable but is edible and is said to be very good. It also drys well and so can be kept for future use. The specimens photographed were collected in an open upland woods in Vermilion County in September.

Polyporus giganteus (Pers.) Fr. *(Fig. 4)*—This plant reminds one of the common *P. frondosus* but the branches of the pileus are fewer in number, larger, and thicker. It is characterized also by the fact that it turns black where bruised and blackens also in drying. The plant is edible but like all the edible species of this genus it is good only when young and tender. The photograph shows a plant collected within the City of Urbana. It was growing on the ground near a buried stump.

Polyporus robiniophilus (Murrill) Lloyd *(Fig. 5)*—Named robiniophilus because it was first found on locust this plant has since been found as a wound parasite on various deciduous trees but most frequently on locust, hackberry and maple. The fine large specimen photographed grew on a hackberry in Urbana. It was produced from a wound about 15 feet above the ground and after it

had been removed several other smaller ones grew from the same place. The tree was finally so weakened at this point that it was blown over during a storm. When fresh the pileus is somewhat watery but firm, whitish, and smooth or nearly so. The context or flesh is white, soft and punky, and has a sweetish odor when dry. The tubes are 0.3 to 1 cm. long, the mouths small and white.

Polyporus induratus Lloyd *(Fig. 6)*—Three specimens of this plant have been collected from a box elder stump near the University campus in Urbana. Since it was new to me I sent a specimen to Mr. C. G. Lloyd of Cincinnati. It proved to be new to him also and he named it as above and reported it with a brief description in his Letter No. 68, page 11, note 743. It is a large plant, extremely tough and spongy when fresh, and becoming hard and punky when dry. The whole plant is light colored when fresh but turns black where bruised or wounded and darkens in drying. The tubes are very minute and only 3 to 5 mm. long.

Polyporus dryadeus (Pers.) Fr. *(Fig. 7)*—This plant is considered rare and is usually reported as growing on living oak trees. The specimen shown in the photograph was found on an old oak stump north of Urbana. I am indebted to Dr. L. O. Overholts for its identification. When fresh the pileus is spongy and somewhat watery, grayish brown in color and glabrous. The context is also brown and becomes somewhat brittle when dry. The tubes are small but sometimes as much as 2 cm. long.

Entoloma grayanum Pk. *(Fig. 8)*—Entoloma is a dangerous genus and this species like its near relatives is probably somewhat poisonous. It is a very ordinary looking mushroom growing 6 to 8 cm. tall with its gray or drab colored cap 3 to 6 cm. broad. The gills are attached and there is no ring on the stem. The spore when caught on paper are light salmon color. The specimens photographed were collected in the University woods near Urbana.

Stropharia caesifolia Pk. *(Fig. 9)*—One morning while collecting *Agaricus campestris* in a cemetery north of Urbana I chanced to pick up a specimen which looked the same as the others but which on turning it over I found to have beautiful light blue gills instead of the familiar pink. Closer examination showed that the gills were attached and indicated that it was a Stropharia instead of an

Fig. 3. Craterellus cornucopioides

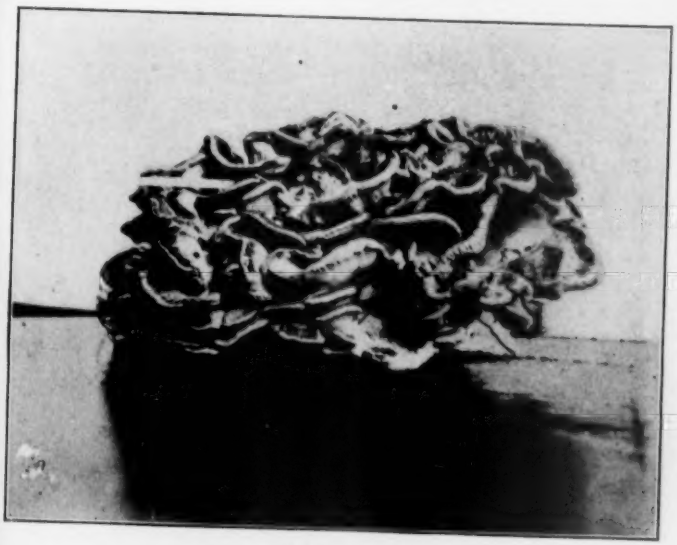


Fig. 4 Polyporus giganteus

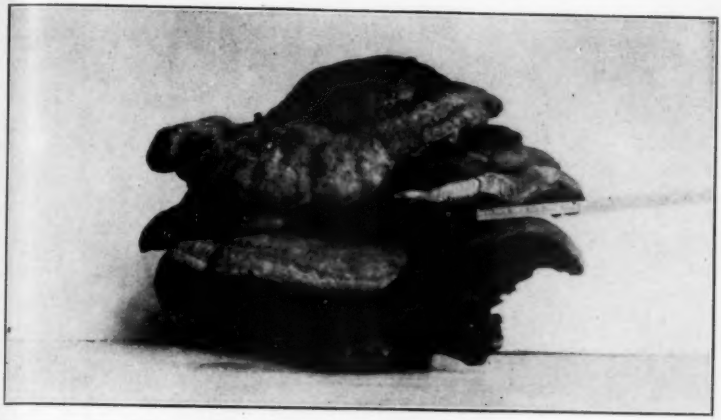


Fig. 5. Polyporus robiniophilus

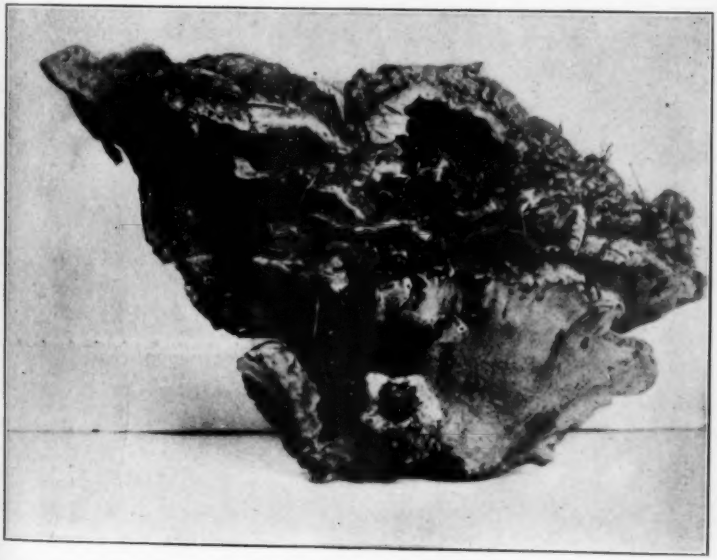


Fig. 6. Polyporus induratus

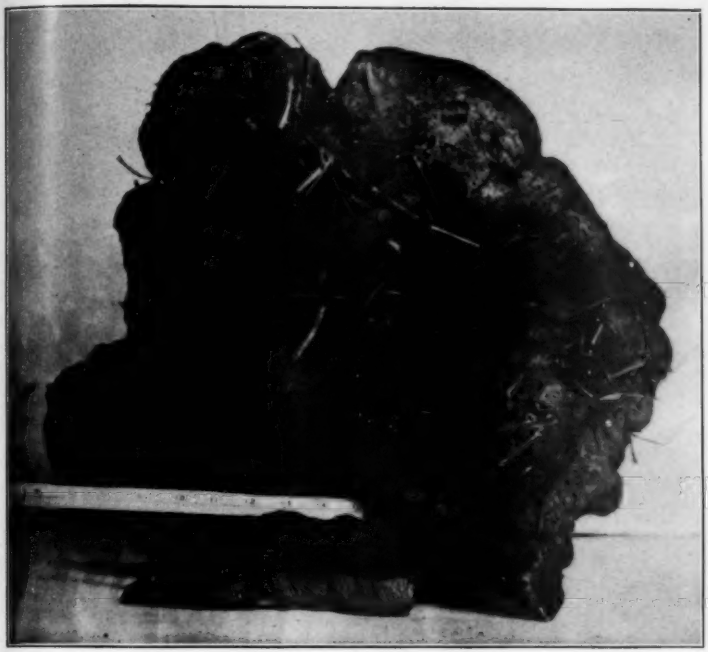


Fig. 7. Polyporus dryadens

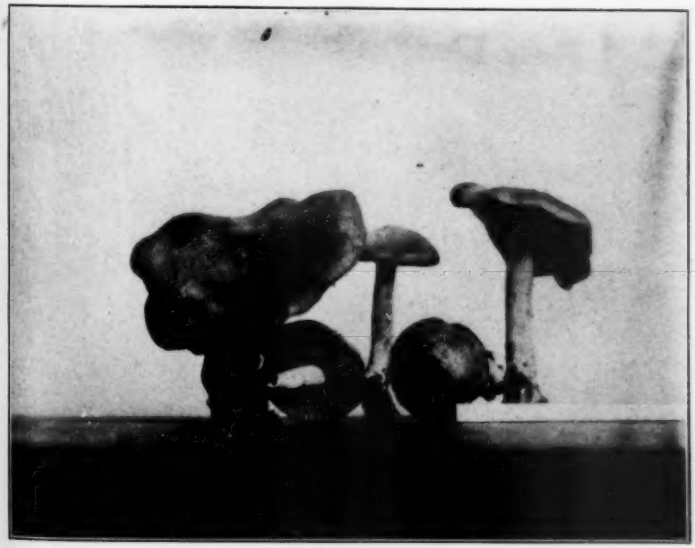


Fig. 8. Entolma grayanum

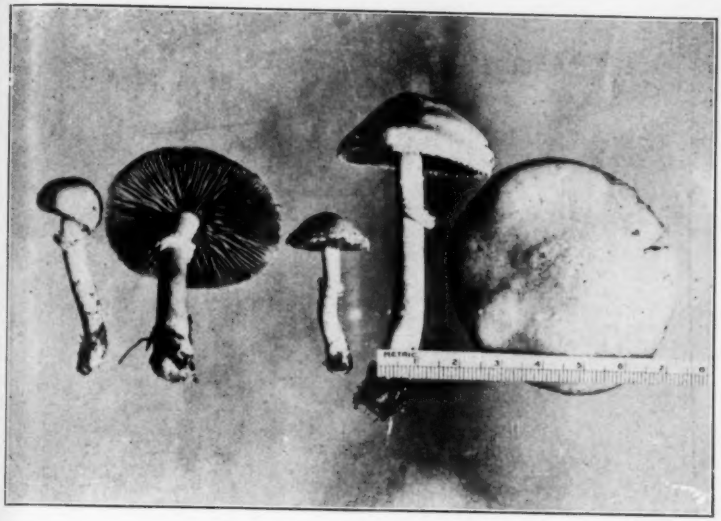


Fig. 9. Stropharia caesifolia

Fig. 10. Tricholoma rutilans

Agaricus. I later found other specimens growing along with the common mushroom. I photographed some of them but for a long time was unable to identify them. Finally I found that the plant was described by Peck[1] in 1895 from a collection sent to him from Kansas. So far as I know it has not been mentioned by anyone since that time. It grows 6 to 8 cm. tall and the caps become as much as 6 cm. broad. The ring is very prominent and the spores are purple brown. The color of the gills alone will identify it. Its edibility has not been tested.

Tricholoma rutilans Schaeff (*Fig. 10*)—This is a species that one would not expect to find commonly in Illinois since it grows only on pine wood or occasionally on hemlock. Nevertheless the plants shown in the photograph were collected in Champaign County. They were growing on a pine stump in the Forestry at the University of Illinois. It is rather a pretty plant, the surface of the cap as well as the lower part of the stem being dark red or purplish. The larger specimens become 10 cm. tall and 10cm. broad. The spores are white, the gills attached, and there is no ring. This species is said to be edible and of good quality although the flesh is somewhat gummy when cooked.

Panus strigosus B. and C.—The hairy Panus was found on living willow along the Sangamon River near the western boundary of Champaign County. This collection was noted by Lloyd in Letter No. 67, page 16, note 691, as the first collection from the west although the species is not uncommon in the east. The plants collected were partly eaten by insects and so not fit to photograph. An excellent photograph was published by Lloyd in Mycological Notes, page 747. Both stem and cap are covered when young with fine soft hairs which become long and stiff as the plant becomes older. The larger specimens are 8 to 10 cm. broad and have stems 6 to 10 cm. long. The gills are slightly decurrent and the spores white. It is edible when young but soon becomes tough.

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[1] Bull. Torrey Bot. Club. 22:489.

[2] Snce wrtng the above I have learned that Dr. Peppoon collected ths plant several years ago n Jo Davess County.

THE JACK OAK*

(Quercus ellipsoidalis)

By William Trelease, University of Illinois.

Northwestward from the head of Lake Michigan the usual sharp distinction between the red oak *(Quercus rubra*—or *maxima* as people are disposed now to call it), the scarlet oak *(Q. coccinea)* and the black oak *(Q. velutina)* is confused by the occurrence of numerous trees that present various types of fruit, rather like that of the scarlet oak but sometimes suggesting that of the red oak, associated with the multiform foliage for which the scarlet and black oaks are noted. Typical red oak and black oak trees very often occur associated with these aberrants: and, except for an infrequent individual now and then which suggests a hybrid, these suffice to indicate that the questionable trees do not represent a transition by which one of the usually recognized types blends into the other.

Many years ago, Engelmann[1] called attention to these peculiar oaks which he was unable to identify elsewhere than with that tree of the lower St. Lawrence to which the younger Michaux[2] gave the specific name *ambigua*, though, being preoccupied for another oak, this name was replaced by him shortly[3] by *borealis*. A peculiar bulging or thickening of the cup-scales of some of the northwestern oaks was noted by Engelmann, who perhaps indicates his difficulty in their identification when he frankly admits that the fruit of *ambigua* as figured by Michaux does not resemble any form of gray-oak acorns he himself has seen.

Though Engelmann was well acquainted with Dr. George Vasey, then a resident of Illinois but editorially connected with The American Entomologist and Botanist,

*Presented in abstract before the Botanical Society of America and the Ecological Society of America, December 29, 1916.

[1] Trans. Acad. Sci. St. Louis, 3: 401; 4: xx.

[2] Hist. Arb. Amer. 2: 120. pl. 24, 1812.

[3] N. A. Sylva, 1: 81;—but the name *ambigua* remains on the plate, 26, and the reason for using it originally is explained in the text.

published in St. Louis, there is no published evidence that he connects his *borealis* oaks with either of the forms into which Vasey had attempted to divide *Q. coccinea* as he understood it. Yet as early as 1870 this attempt had been made,* and one of the forms, his var. *microcarpa,* is unmistakably figured. It may be that Vasey meant to refer this form to *Q. coccinea microcarpa* Torrey, of the Southwest—now known as *Q. texana,* from which it is distinct though even the latter species is so like in foliage to *Q. palustris* as to have passed for it. Most of the specimens collected by Dr. Vasey are without definite indication of locality; but he is known to have collected extensively about Ringwood, in one of the northernmost counties of Illinois, and one such specimen is labeled as from Ringwood.

Also before Englemann's short publication on these ambiguous oaks of the lake region, one of the most acute local botanists who has yet appeared in the United States, M. S. Bebb, had puzzled over them as they occur in another of the northern counties of Illinois, where, about Fountaindale, he studied them in numerous individual trees of which he made excellent specimens, some of which were communicated to correspondents and the remainder of which have come to rest as a part of his personal herbarium, now housed in the Field Museum of Chicago. Unfortunately the conservatism for which Bebb was noted kept him from recording even on the labels his determination of most of these specimens, though some few are labeled as *Quercus rubra* or as *Q. coccinea.*

In 1898 Rev. E. J. Hall, to whom the flora of the neighborhood of Chicago was better known than it has ever been to another, described* and figured what he took for a local hybrid of *Quercus coccinea* and *Q. palustris:* and the following year, without indicating its relation, if any, to this hybrid, he characterized† a common oak of that region under the specific name *ellipsoidalis,* given because of the elongated acorns produced by trees that he took to be typical of it. In aspect, bark, and foliage this species was made to compare more or less closely with *Quercus palus-*

*American Entomol. & Bot. 1:344-5. f. 213.

*Botanical Gazette, 16:53. pl. 5-6.—Specimens of this, which I take for what is here called *Q. ellipsoidalis intermedia,* occur from Thornton, Illinois, as *Hill, 64/96, 296/97.*

†Botanical Gazette. 27: 204. pl. 2-3.

tris; but in fruiting cup, with *Q. coccinea*[1] from which its foliage differed in less intense autumnal coloration. Locally, it seems not to have been distinguished commonly by name from the associated black oak, *Q. velutina,* though Mr. Hill mentions the name yellow oak as applied to it by one person.

Since its publication, *Quercus ellipsoidalis* has been recognized generally as a valid species, and it is figured in a number of books.[2] It appears to be one of the dominant oaks of the region west of Lake Michigan and south of Lake Superior and extends through Minnesota and Wisconsin to northeastern Iowa, and thence to the country immediately southeast of Chicago. This distribution is indicated on a small map accompanying Hough's excellent account and photographic illustrations of the species.

Though the supposed hybrid of *Quercus palustris* and *Q. coccinea* bore relatively short and thick acorns, and his description of *Q. ellipsoidalis* showed that what he took for this species sometimes produces nearly spherical acorns, Mr. Hill was careful to differentiate his new species from the associated oaks referred to *coccinea* and *velutina;* and this has led those who have dealt with it of recent years to dwell upon the deep turbinate cup and slender elongated acorn as its chief differentials, which, as is shown in the well-drawn figures of the "Minnesota Trees and Shrubs", stand in marked contrast with the otherwise scarcely distinguishable oak called *Q. coccinea,* of the region in which *Q. ellipsoidalis* grows. Though an early contributor to The American Entomologist and Botanist, Mr. Hill does not seem to have recognized in these oaks the assemblage that Vasey had considered a generation earlier, nor to have noted that Vasey's *coccinea microcarpa* well pictures his own typical *ellipsoidalis.*

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[1] Specimens representing *coccinea* as understood by Mr. Hill, which I take for what is here called *Q. ellipsoidalis depressa,* occur from Thornton *(Hill, 161a/95, 78/96, 82/96, 293/97, 165/95, 83/96, 121/01, 122/01, 15/99,* Glenwood *(Hill 81/96, 90/96, 299/97),* Barington *(Hill, 215/00, 216/00),* and Wauconda *(Hill, 334/98,* in Illinois, and from Hammond, Indiana *(Hill, 73/91),* and Liverpool, Indiana *(Hill, 334/98, 335/98);* and, without name, from Thornton *(Hill, 162/95, 164/95, 65/96, 79/96, 81/96),* Glenwood *(Hill, 170/95, 88/96),* and West Pulman *(Hill, 147/9/95, 70-72/96).* Other specimens, referred to *Q. velutina,* occur from Willow Springs, *(Hill, 140/90),* and morely *(Hill, 156/95)* in Illinois, and from Liverpool, Indiana *(Hill, 337/98).*

[2] Britton and Brown, Ill. Flora, 2 ed. 1:618. f. 1518.—Britton and Shafer, N. A. Trees. 291. f. 243.—Clements et al., Minnesota Trees and Shrubs. 261. f. —Deam, Rept. Indiana Board of Forestry. 11 202. pl. 56.—Hough, Handbook. 144. ff.—Otis, Micigan Trees, 114. f.—Sargent, Manual of Trees. 234. f. 189.—Robinson and Fernald, Gray's New Manual, 7 ed. 342. f. 683.—Trelease, Proc. Amer. Phos. Soc. 51. pl. 11.

During several seasons past, in cooperation with the State Laboratory of Natural History, I have spent some little time in the examination of these scarlet and ellipsoid oaks as they occur in northern Illinois, and I have viewed critically such herbarium material of *Q. coccinea* and *Q. ellipsoidalis* as I have been able to see in herbaria, with the result of finding it impossible to recognize the former species in the region in which the latter occurs;—what has passed for *Q. coccinea* west of Lake Michigan and north of, say, the lower Wabash river and the granite mountains about Bismarck, Missouri, being either so-called in the broader and older sense in which even *Q. velutina* has passed for a variety of *Q. coccinea*, or with reference to the rounder-fruited form of *Q. ellipsoidalis*.

While *Quercus ellipsoidalis* seems to be limited on the east by Lake Michigan, and on the north by Lake Superior, its range to the west is not closely fixed; and, particularly, I have had difficulty in finding any reason for its abrupt cessation in the south. So far as evidence has been procurable, it does not occur on or to the south of a line connecting Kankakee, LaSalle, and Rock Island, in Illinois. On the other hand, it is present in quantity about Glenwood and Thornton, south of Chicago, occurs sparingly in the vicinity of Joliet, is abundant on the Fox River about Aurora, in the neighborhood of Samonauk, and around Dixon, and it crosses the Mississippi river somewhere near Fulton, Illinois, and Clinton, Iowa. North of this, it is found everywhere where oaks occur.

No connection is apparent between the southern termination of its range and the soil belts or glacier limits recognized in Illinois, and as yet it has not been found to follow the larger streams, though its abundance on the upper Rock River would lead one to suspect that further search may reveal its presence as far south as Rock Island,—where, however, I have been unable to find it. Though I have seen no specimens from the upper peninsula of Michigan, it is evidently this species that Farwell* reports as there becoming a large tree in the valleys but reduced to a bushy shrub or small scraggy tree along rock ledges, under the name *Q. rubra borealis*.

*Rep. Mich. Acad. Sci. 6:206. 1904.

Though not distinguished by a common name near the limits of its range, it appears to be known in northwestern Illinois as jack oak,—occasionally varied into black jack, though not through confusion with the true black jack, *Q. marilandica*. It is a tree of the timber fringe along water courses in the flat prairie region, forms an abundant constituent of similar belts flanking the more northern rivers, and enters into the "oak openings" that are characteristic of the rolling prairies of Wisconsin.

This jack oak is a tree which closely resembles the black oak (pl. 139), and, like the black oak, it holds its dried foliage far into the winter, so that from a distance individuals of these species may be picked out then when in groves that contain a good deal of red oak. Though on the sandy soil in its type locality it does not become very large, and may fruit when scarcely ten feet high, it reaches a height of sixty feet or more, with a trunk diameter of nearly three feet, on the rich land in western Illinois, as about Morrison. More finely and densely branched than the red oak usually is, in this respect resembling the pin oak and black oak, it is less percurrent than the pin oak usually becomes, and like the black oak and the pin oak it has more glossy foliage than the red oak, and its leaves (pl. 141) are varying and prevailingly as deeply cut as those of the pin oak or of the very variable black oak. In external bark characters (pl. 140), it stands between the red oak and the black oak. Some trees have a smoother trunk than most red oaks, but others are quite as rough as even any of the associated black oak trees. Its inner bark lacks the characteristic yellow coloration of that of the black oak.

As Oersted insisted long ago, and as I have shown for our black oaks collectively,* and Miss Cobb for our eastern white oaks,† the mature buds of oaks afford fairly dependable specific characters. In this respect, *Quercus ellipsoidalis* stands out distinctly among the oaks that it occurs with (pl. 143). *Quercus palustris,* which barely enters its range from the south, is readily known by its rather small conical glabrous brown buds; *Q. maxima* by its much larger equally glabrous red-brown buds; and *Q. velutina* by its still larger often 5-angled or 5-grooved

*Proc. Amer. Philosoph. Soc. 51:167-171. pl. 10-13.
†Proc. Amer. Philosoph. Soc. 54165-174. pl. 4-6.

very hairy buds. The jack oak has buds more nearly like those of the eastern scarlet oak though smaller,—distinctly smaller and usually blunter than those of the black oak and, like those of *Q. coccinea,* different from those of the red and pin oaks in being more or less silky pubescent. This is a character that varies somewhat in the scarlet oak. In *Q. ellipsoidalis* there is still greater variability, for some trees have nearly glabrous buds, and others distinctly canescent buds. One of the earliest students of bud characters in this country, Dr. Brendel of Peoria, for whom what we now know as *Quercus velutina* represented the scarlet oak, records‡ that after coming to believe that he had found a dependable character for this in its large pubescent angular buds his faith in this mark was shaken by finding that the *coccinea* of northern Illinois has round and smaller buds more like those of the red oak,—this of course referring to the *ellipsoidalis* aggregate of forms, shortly afterward differentiated though not separated from *coccinea* by Vasey.

Though the extremes under which the acorns of *Quercus ellipsoidalis* occur pass into one another so that the recognition of forms based on them is scarcely more than a convenient way of ensuring their reference to this alliance, the fruit of a given tree is fairly uniform: and in this respect the trees will probably be found to breed true. Whether this is equally likely for the different foliage forms seems questionable: but this has never been tested, so far as I know, for either this species or the still more variable black oak. As yet, I have been unable to correlate the bark, bud, foliage, and fruit differences that have been observed, so that for the present it seems possible to differentiate the forms only on the following characters:—
Leaves broadly elliptic, regularly pinnatifid.

Cup more or less turbinate, not dilated much beyond the diameter of the acorn.
Acorn elongated, about in the ratio of 2:3.
Scales of cup not incurved, *Q. ellipsoidalis* Hill.
Scales incurved about the acorn, f. *incurva* Trel.
Acorn broadly ovoid, about in the ration of 3:4. f. *intermedia* Vasey.
Acorn subglobose. f. *depressa* Vasey.

‡Amer. Naturalist 4:248. 1870.

Cup dilated saucer-shaped, abruptly constricted about the acorn. f. *coronata* Vasey.

Leaves obovate-oblong, irregularly lobed or incised. f. *heterophylla* Trel.

So far as I know, each of the fruit forms (pl. 142) may be expected wherever the species occurs, though the *depressa* and *coronata* forms are less frequent than those with the more typical elongated acorns or narrow cups. The heterophyllous aberrant, comparable with forms offered by many other species of oak, has been collected at Spooner Lake, Wisconsin, *(Miss Ruth Marshall),* and in Clayton County, Iowa *(Pammel).*

The synthetic characters of *Quercus ellipsoidalis* have led to the supposition that one or more of the forms or individuals that are here called by this name may be really of hybrid origin between *Quercus palustris, Q. coccinea, Q. velutina,*—which is meant sometimes when the name *Q. coccinea* is used in the former broad sense, and possibly *Q. maxima.* The tree which Mr. Hill considered to be a hybrid of *palustris* and *coccinea* before he distinguished his own species, as is noted on one of the sheets representing it was considered subsequently to be rather a cross between *palustris* and *ellipsoidalis* itself; but I should say that it is merely a form of the latter. Though of restricted range, for an oak, this species is too abundant in its region, and too distinct from its congeners, to be considered as of a different nature from these notwithstanding a greater variety in fruit and buds than any of them shows except *Q. velutina.* On the other hand, there is no reason to suppose that it may not cross with one or more of these species, and as it becomes better known in individual trees such hybrids are very likely to be discovered.

Specimens that suggest such an origin are one from Kilbourn, Wisconsin, collected by Miss Marshall in August, 1916, which in leaf and fruit is scarcely more than the less-lobed form of *velutina* though as yet with relatively small buds for the black oak; and an eight-foot bushy tree in the sands of Chicago which Dr. Pepoon collected in September, 1916. Though the acorns of this are more persistently downy than is usual in *ellipsoidalis* and its buds are un-

usually large and hairy, the foliage and fruiting cups are as they should be in *ellipsoidalis*. So far as I can see now, therefore, Miss Marshall's tree must be taken for *velutina* and Dr. Pepoon's for *ellipsoidalis*.

On the other hand, among the many specimens collected by Mr. Bebb about Fountaindale are three sheets in the Field Museum which really appears to represent a hybrid. Their leaves are of the hard texture, moderate size and rather rounded outline with deep open sinuses that are frequently found in *Q. coccinea,* and they are glabrous except for axillary domatia beneath. The rather large fruit, with acorns 15 mm., and cups over 20 mm. in

Distribution of Jack Oak

diameter, might pass for that of *coccinea*. But the buds, much larger than in *ellipsoidalis* (as much as 3×7 mm.) though not larger than in *coccinea,* are rusty-hairy as in *velutina* as in which they may be somewhat prismatic, thus differing from *ellipsoidalis* and the related but not associated *coccinea*. For this hybrid, represented by sheets 5766 *(Bebb, 16),* 6129 *(Bebb, 47,* "Westfield Woods") and 204583, in the herbarium of the Field Museum, I have proposed* the name ×*Q. palaeolithicola.*

Specimens that I have examined show the distribution of *Quercus ellipsoidalis* in its various forms to be as indicated on the accompanyig sketch-map and in the following tabulation:—

*Proc. Amer. Philosoph. Soc. 56: 50, pl. 1. 1917.

Minnesota:—Cass County (*Ballard,* 1893). Crow Wing County, (*Sargent,* 1882). Hennepin County (*Engelmann,* 1878; *Mearns,* 617; *Sargent,* 1882; *Sandberg,* 1890; *Schuette; Sheldon,* 1895; *Waggoner,* 1916).

Wisconsin:—Bayfield County (*Gillman,* 1876). Forest County (*Johnson,* 1814). Washburn County (*Miss Marshall,* 1916). Oneida County (*Roth,* 1897). Marinette County (*Shuette).* Kewaunee County (*Shuette).* St. Croix Co. (*Miss Mulford,* 1686). Brown Co. (*Schuette*). Waupaca Co. (*Garesche,* 1907). Winnebago Co. (*Kellerman,* 1878). Juneau Co. (*Mearns,* 620). Sauk Co. (*Miss Marshall,* 1916). Dane Co. (*Denniston & Davis,* 5, 6, 8, 9, 12). Milwaukee Co. (*Lapham,*—as "*Q. palustris*").

Iowa:—Fayette Co. (*Fink,* 513, 515; *Gardner,* 335). Mitchell Co. (*Mrs. Tuttle*). Black Hawk Co. (*Hitchcock,* 1889). Hardin Co. (*Pammel, Hume & Fitz,* 1605, 1609). Boone Co. (*Pammel,* 1809). Story Co. (*Pammel & Ashe,* 1836, 1838). Jackson Co. (*Lazell,* 1916). Clinton Co. (*Butler,* 1878). "N. E. Iowa" (*Schultz*).

Illinois:—Jo Daviess Co. (*Pepoon,* 62; *Umbach,* 1896). Stephenson Co. (*Trelease,* 1916). Whiteside Co. (*Trelease,* 1617-8-9). Lee Co. (*Trelease,* 1916). Ogle Co. (*Terry,* 1907). Winnebago Co. (*Bebb,* 1870, 1, 4, 5-10, 12-14, 17-20, 43-5, 47-52, 54; *Miss Marshall,* 1916). McHenry Co. probably about Ringwood (*Vasey,* "Illinois", 1862, 1, 3, 6, 9, 15, 16, 18). Lake Co. (*Engelmann,* 1882; *Gates,* 2981; *Sherff,* 1893, 1912). Cook Co. (*Calkins,* 229; *Mrs. Chase,* 46, 55, 61, 749, 752-4, 1003-5, 1007, 1018-1022, 1515-6); *Hill,* 129/91, 134/91, 26/92, 104/92, 134/2/94, 150/95, 151/95, 152/95, 152a/95, 166/95, 167/95, 168/95, 169/95, 172/95, 173/95, 174/95, 175/96, 64/96, 73-76/96, 84/96, 85/96, 86/96, 91/96, 93/96, 94/96, 98/96, 173/96, 329/98, 330/98, 19/99, 237/99, 85/199, 7/02; *Smith,* 1802, 1902; 1912; *Trelease,* 1916). Will Co. (*Ferris,* 1916; *Hill,* 157/95, 158/95, 298/97, 290/97).

Indiana:—Lake Co. Hammond (*Hill,* 134/91). Liverpool (*Hill,* 333/98, 338/98). Miller (*Duesner,* 1908). Glen Park (*Smith,* 1912).

Michigan:—Ionia Co. Muir (*Smith,* 1-3). Washtenaw Co. Dexter (*Davis,* 1-3).

So far as I have been able to see, nothing very peculiar marks the ecological occurrence of *Quercus ellipsoidalis*. Its associates where I have found it in Illinois are the usual components of groves in the northern part of the State, and there is no evidence that it is influenced by them or influences them materially. As has been stated already, its distribution has not been connected either with evident barriers, drainage systems, or particular superficial glacial deposits. On the other hand, the southern limit of its occurrence in the State coincides in general with the southern limit of underlying geological strata older than the Carboniferous, and its entire known distribution falls in Silurian, Ordovician and Cambrian regions: but in eastern Illinois it does not reach the southern limits of the Silurian. I have no knowledge of its occurrence over these older rocks to the southeast of the Lake, for it is reported for Lake County, Indiana, only, and, so far as I know, is not found in western Ohio, which is of similar geologic age.

The absence of the jack oak from this part of the adjacent older formations requires separate consideration, though its explanation may perhaps be sought in the varying chemical composition of the soil through the territory covered by these older outcroppings; but the failure of the tree to penetrate the Carboniferous territory, which constitutes the larger part of Illinois, apparently bears a very close connection with the circumstance brought to my attention by my former colleague, Dr. J. L. Rich, that the glacial drift which overlies local rocks in this region may be all but exclusively derived from rock of the immediately adjacent country.* If this conclusion be correct, the peculiar and abrupt ending of the range of the jack oak in Illinois may be due primarily to its intolerance of the iron, sulphur, magnesium, etc., with which the rocks of the coal country are charged and the presence of which is very evident in the water of this region.

*Alden, Professional Paper, U. S. Geol. Survey. 34:75, 1904.—In a very extensive study of the soils of southern Wisconsin, though only 50 per cent of the drift materials were found to be of local origin in one case, the general local constituents comprised between 68 and 97 per cent in

all others—and the average of the entire series showed about 87 per cent to have originated locally or at no great distance.

If I understand my colleague, Professor T. E. Savage, correctly, his extensive studies of Champaign County do not warrant a belief that the largest part of even the very deep drift which covers central Illinois has originated more than fifty miles away from its present position.

The University of Illinois, March, 1919.

Explanation of Plates.

139. *Quercus ellipsoidalis.* The tree from which type collections were made. Photographed near Thornton by Mr. C. F. Millspaugh in company with the author of the species. Published by permission of the Field Museum of Natural History.

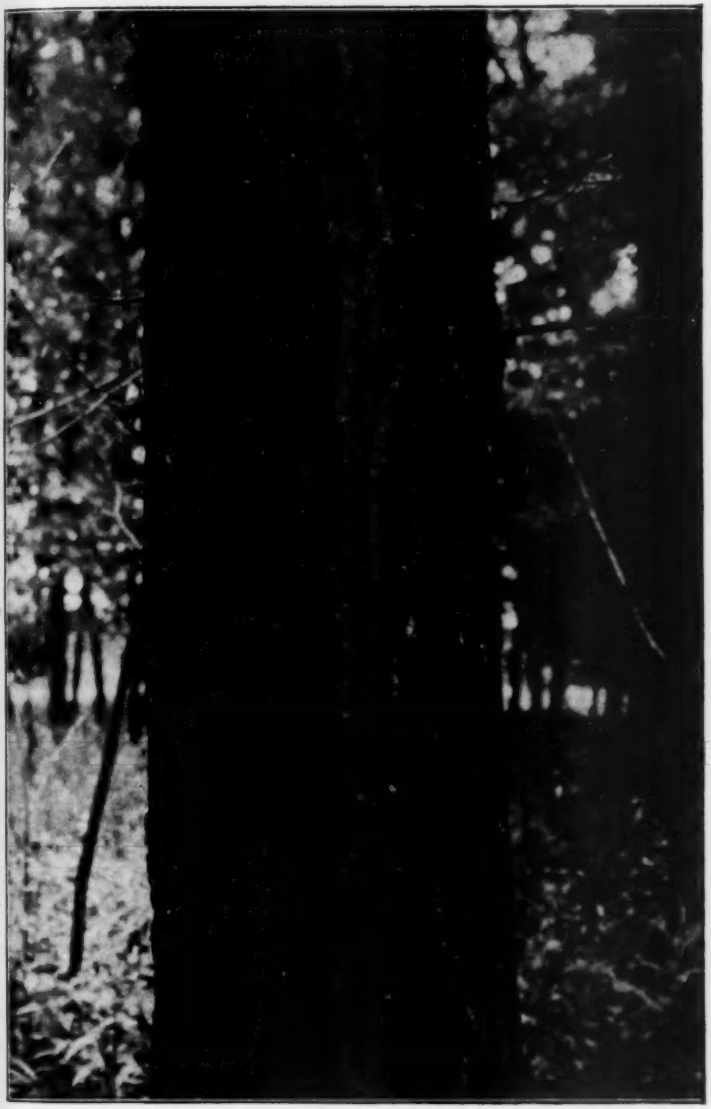
140. *Quercus ellipsoidalis.* Representative but rather rough bark. Photographed near Thornton by Dr. C. F. Millspaugh. Published by permission of the Field Museum of Natural History.

141. *Quercus ellipsoidalis.* Two of the many foliage forms found in the type region of Cook Co., Illinois, about one-third natural size. From specimens in the Hill herbarium at the University of Illinois.

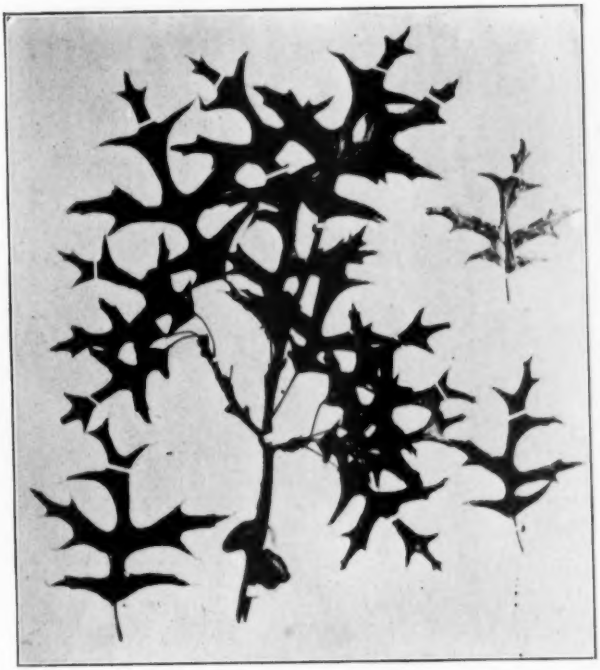
142. *Quercus ellipsoidalis.* Forms of fruit: natural size. Upper row, the typical form. Second row, f. *incurva.* Middle row. f. *intermedia.* Fourth row, f. *depressa.* Bottom row, f. *coronata.*

143. Above: buds of *Quercus ellipsoidalis,* in the upper row; *Q. palustris* in the center, *Q. coccinea* at the left, and *Q. velutina* at the right, in the lower row. All enlarged 4 diameters. Below: Range of variability in the fruit of *Q. velutina,* for comparison with the range in *ellipsoidalis* fruit. All of natural size.

JACK OAK (139)

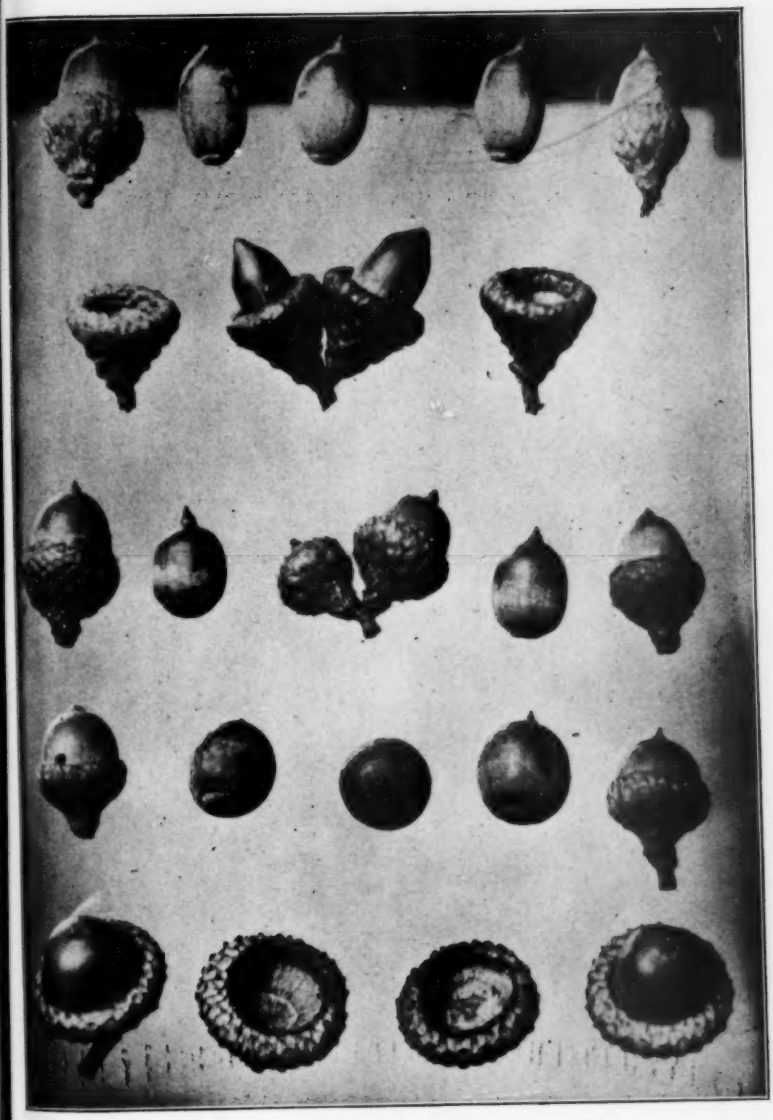


Jack Oak (140)



Jack Oak (141)

Jack Oak (141)



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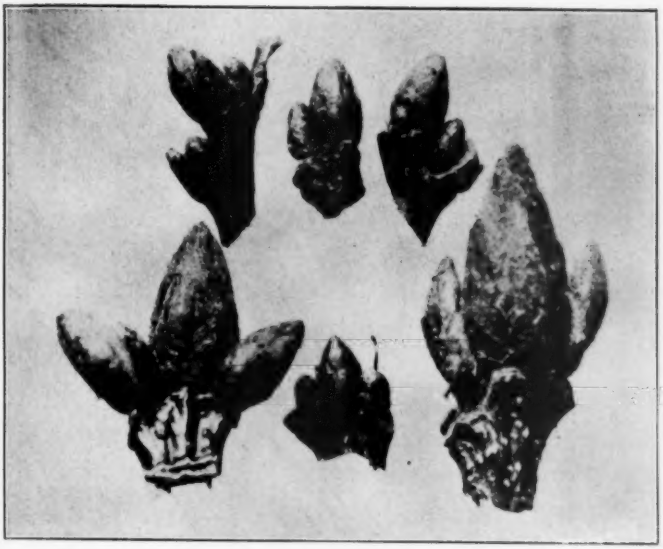
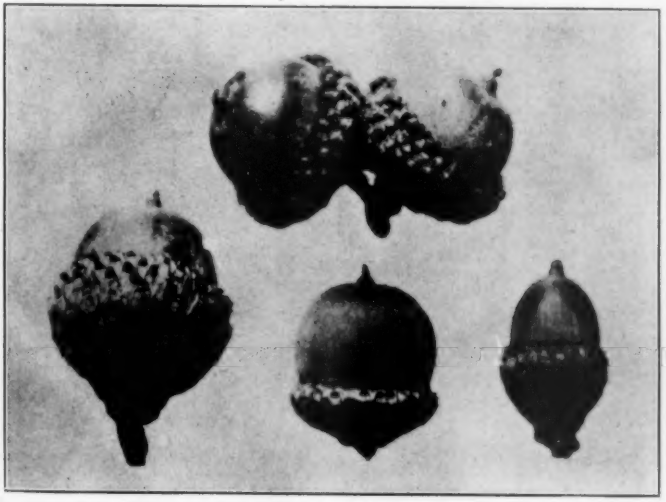


Jack Oak.



Jack Oak (143)

STUDIES IN THE NORTH AMERICAN OPUNTIA

C. Z. Nelson, Galesburg.

In the years of 1891 and 1892 while a student in Denver, Colo., the writer became closely associated with Prof. F. E. Scanlon and Dr. J. F. Saler. Prof. Scanlon was an assayer and mine expert of high standing while Dr. Saler was a physician and chemist. Both of them were also good botanists. During the summers of 1891 to 1895 we visited and camped in several localities in Colorado, Arizona and New Mexico. In 1896 I returned to Illinois, maintaining regular correspondence with my former chums.

In 1900 both of them made itineries into Mexico in the interest of different mining concerns and in their travels collected much botanical material which was sent to me to care for and to identify.

Unfortunately the activity of my friends was of short duration. Mr. Scanlon succumbing to some form of fever in the State of Oaxaco, April 3, 1902, and Saler was last heard from in Cerco Blanco, Chile, June 9, 1903.

Among other important correspondents the writer has been much aided with material and data by Prof. Mackensen, San Antonia, Texas; Dr. Forrest Shreve, Tucson, Arizona; Jesus Gonzales, Paras, Mexico; J. E. Brown, Sanborn, Kans.; B. R. Russell, San Saba, Texas; L. B. Childs, Boerne, Texas, and Pacific Grove, Calif.; F. H. Young, Haines City, Fla.; Ella Huber, Ybor City, Fla., and scores of others. From the plants received the following new species have been described and published in the Galesburg Republican Register, July 20, 1915:

Opuntia youngi, sp nov.

Type loc: nine miles northeast of Tampa, Fla.

Distribution: Extending northward probably to Atlanta, Ga. Diffuse and prostrate with young joints ascending or erect. Roots fibrous. Joints moderately thick, ovate, obovate or circular. 4 to 6 cm. wide and 5 to 10 cm. long. Bright green, arcoles tinged purple, tuberculate, causing the margins to become indented and undulate. Specimens dant have borne from 1 to 3 needle-like spines 5 to 20 mm. long. Variegated or gray with darker tip and base. Wool sparse, light gray bristles in pencilate tufts, dingy yellow to almost gray. Flowers opening yellow shading to orange with brownish center. Fruit long pyriform with shallow umbellicus.

Opuntia seguina, sp nov.

Type loc: Seguin, Texas.

Distribution: Lococit, and surrounding country.

Prostrate, joints obovate, bright green, moderately thick. Slightly wrinkled and with elevated arcoles. 4 cm. wide by 5.5 cm. long. Wool not apparent. Bristles light brown. Spines 1 to commonly 2, unequal, 12 to 25 mm. long. Variegated or brown with lighter to white tips, sometimes 1 to 2 smaller secondary ones. Flowers yellow with brownish center. Fruit long clavate. 5 cm. long by 1 cm. broad, greenish purple, with few low linear tubercles and areoles bearing brown bristles, umbellicus funnel form, seed proportionally large. 3.5 mm. thick, sub-reniform white, and slightly beaked with the small but broad border. Also frequent in loose sand south of San Antonio.

Opuntia longiglochia sp nov. (Mackensen, No. 125).

Type loc: San Antonia, Texas.

Distribution: Lococit, and southwestward.

Erect and spreading with age, often forming a dense bush 9 to 12 cm. high. Joints obovate bright glossy green 1.5 cm. long and 1 cm. wide. Areoles large, filled with remarkably long, coarse and bristle-like bristles. Brown in crescent form tufts 1 mm. long. Spines 1 to commonly 2, compressed and twisted, about 4 cm. long, sulphur yellow to amber at the base. Fruit clavate, one-half inch thick and two and one-half long. Umbellicus funnel form. Flowers not in perfect condition, apparently light yellow with brownish or redish center, characterized by its remarkably long and brush-like tufts of brown bristles.

Opuntia shreveana. sp. nov.

Type loc: Tucson, Arizona.

Distribution: Tucson, south and westeward.

Plant 60 to 140 cm. high, nearly as broad as tall with a short and somewhat definite trunk. Joints circular or broader than long. 2dm. or more. Blue green, with a space about the areoles and the margins deep purple or sometimes especially in new growth pinkish or purplish throughout. Areoles 1.5 cm. apart bearing chestnut brown bristles, usually spineless, when present usually 1 or 2, needle-like and chestnut brown, 2 to 4 mm. long. Flowers deep yellow, 6 to 7 cm. across. Fruit purplish, short oblong with shallow umbellicus. One of our handsomest plat optunia material and data furnished by Forrest Shreve, Desert laboratory, Tucson, Arizona.

Two specimens also in Mackensen's collection without data or number, one from Haines Wells, Arizona. While other genera of the family have also been considered, the *Optuna* on account of their more diversified characters and more abundant distribution has furnished the best field and in addition, the following notations may be useful to future botanists who undertake their study.

It was my original idea to adjust the descriptions to the more definite types of already well defined species so as to cover the frequent large quantity of near related and not sufficiently distinct types, so that the great maze of variations can be definitely referred to some recognized type, and to exact a type locality where typical specimens of each species and variety accredited to the United States can be secured.

The portion east of the Missippi except part of the lower regions of Florida has been fairly well canvassed and examined and the following species can be reported: *Opuntia opuntia* occurs intermittently along the Atlantic coast from Rhode Island south at least to Titusville, Fla., eastward in Florida and very abundant in Polk County. *O. austrina* (not true to description, very much resembling *O. tennispina,* but always smaller and sub-prostrate) Palm Beach to Miami and inland.

O. Tuna. Key West, Fla.

Specimens of what is supposed to be *O. dillenii* have been secured from the main coast of Florida. The most perfect by E. N. Reasoner. None show any definite difference from *O. Tuna* except in size.

O. pes-corvi. Sand wastes North and South Carolina, more abundant in the mountain regions in Virginia and West Virginia. This species although often resembling *O. opuntia* is always smaller and the older growths always prostrate.

O. youngi. Sand wastes a few miles below Atlanta, Ga., to Ybor City, Fla.

O. pollardii. Coast near Biloxi, Miss.

O. Traccyi. Sand wastes northward of Biloxi. One of our smallest and spineist optuna. Spines are often more than twice the length of the joint.

O. humifusa. Havana, Ill., and southward along the Illinois river. Raffinesque's type was undoubtedly from near either Quiver or Beardstown. Therefore the true type is procumbent or prostrate, with redish brown bristles, 1 to 2 strong variegated spines and 1 to 3 secondary gray ones. Flowers bright yellow. Fruit greenish or purplish on upper side, small areoles bearing short bristles, pyriform, with deep umbellicus, seed light gray.

The unlimited number of variations extending from this locality westward well into California and merging into *O. camanchica* in the prostrate forms and *O. leptocarpa* in the upright forms unless well marked cannot reasonably be separated as species.

Opuntia fragalis. Distribution, sterile but often moist situations, Lake Michigan to the foot-hills of eastern Colorado, thence southward into New Mexico, where it becomes *var. brachyarthera.* Northern limits extending into Canada southern limits; Kansas, central Iowa and southern Wisconsin. The only dry fruited species east of the Mississippi. This little *Opuntia* is also the most widely distributed and the most definite in character of any in the genus.

There is also a small red bristled *opuntia* peculiar to Ohio, which in the near future is very likely to be recognized as a species.

Regarding the great quantity and variation in these plants in the southwest, Botanists of recent years have shown an inclination for defining every type into a species. The writer can hardly agree with either this idea or the idea of referring all near related to one species. The prevailing specific requirements should be adhered to in this class of plants the same as in all others. We are all familiar with the vast variations in our cultivated apple. Several types of well marked fruits; color of bark both on old trunks and twigs, also difference in color of the leaves. But they are all of one species and no Botanist would think of dividing it into as many species as there are even decided variations. Neither would we think of referring the apricot to the peach or plum on the supposition that it is a hybrid between the two.

In *prunus Pennsylvanica* and *P. serotina* we have much less difference in the trees and leaves than we have in some of the forms of the apple and their specific difference is chiefly in their mode of flowering and fruiting.

We would therefore suggest that by applying the same methods to the opuntia as is applied to other plants, and basing their specific status on definite characters it is no question but what these plants can be defined and understood as accurately as any other.

As an illustration, *O. leptocarpa* was established by Mackensen by its fruit, still the plant itself is more definite than the fruit. Experiments by B. R. Russell, San Saba, Texas, developed that ten cuttings from the same plant produced six forms of fruit, but all the plants retained the resemblance of the parent.

Many instances of confusion among recent botanists are also evident, many of which can be traced by the difference in geographical location while others can be accounted for by the difference in geological conditions.

We have in *Opuntia arizonica,* Griffiths, C. N. H. 12:402, 1909, wherein Dr. Rose also states that he had probably recognized this opuntia as a new species, does not occur in Arizona as described. If the specimen in the writer's col-

lection and identified by Dr. Griffiths as a good type is correct, then the description needs amending. It is the only type that can be taken as *O. arizonica,* although it is more plentiful in New Mexico than any place in Arizona and very common in central Texas.

There is also *O. discata.* Griffiths. Rep. Mo. Bot. Gard. 266, 1908. Type locality also near Tucson, has proved by cultivation to be only a more glaucous and spreading form, with more circular joints than the true *O. engelmannii* Salm-Dyck. Bost. Jour. Nat. Hist. 6; 1850, which may be regarded as typical in the St. Ulalia mountains.

A peculiar instance also is the two names of *Opuntia microcarpa.*

O. microcarpa. Eng. Emory mil. recon. Folio 7, 1884. Reported by Emory to be abundant in the Del Norte and Gila regions, which would be in southwestern New Mexico.

O. microcarpa. Schum. Gesem, Cacteen, 1899. Cal Du Sac. Haiti. It is difficult to understand Drs. Britton and Rose's opinion that Schumann's name is a homonym of Engelmann's (Smith Misc. coll. 50:522). Thorough investigation evidences that no opuntia answering to Dr. Engelmann's description exists in the given locality. Nor has any been collected and authentically reported since. Neither is there any herbarium specimen known. Engelmann's description was from a drawing which may not have been accurate. But even then berries three to four inches long are not small for an opuntia.

O. pharacantha is the smallest opuntia in this locality and Engelmannii cyclodes the most common. Therefore if Schumann's plant proves a good species it could retain the name and Engelmann's name could be regarded as a nomnudum. There also appears to be a misunderstanding in *Opuntia griffithsiana.* Mack. and *O. Mackenseni.* Rose. The descriptions of the two plants differ very little and the specimens received from Prof. Mackensen differ less.

By eliminating the many indefinite characters on which many species have been based we can recognize the following as good types of the tall growing opuntia. Engelmannii, N. W. Mexico and Ariz. (var. discata), dark green and glaucous, short almost black bristles and gray deflexed spines.

Lindheimeri. New Brunsfels, Texas. South, north and westward. Bright green. Bristles and spines various but always yellow or greenish yellow. O. arizonica, Tucson, Arizona; eastward far into Texas. Bright green. Bristles various shades of brown. Spines yellow with colored base. *O. occidentalis* and *litoralis* come under the lindheimer type as does also linguiformis but are well described in other literature and quite distinct. O. chlorotica can hardly be classed here on account of being smaller in every way.

O. Toumeyi is also much smaller than O. arizonica, although of the same type. O. castillea Griff. Tucson, Ariz., is of the Ficus-Indica type. Dark green slightly glaucous and few spined. O. fusicanlis appears to be a variety of it with thicker and larger joints.

Another peculiar incident is O. Elisiana. Griff. the only good types definitely known are those cultivated and advertised by B. R. Russell, San Saba, Texas, as his natural spineless cactus. It appears by Emory's records that this plant also received the unpublished name of anacantha by Engelmann. From information by old settlers it appears that in earlier years this plant like mammillaria lasiacantha was abundant in central Texas, and the former very likely also in New Mexico. Many reasons for their near extinction have been proposed, the most logical being that they were obliterated by the vast herds of grazing cattle.

Papers on Zoology

A MUSSEL SURVEY OF THE UPPER WATERS OF THE VERMILION RIVER WITH SPECIAL REFERENCE TO THE SALT FORK[1]

By Frank Collins Baker and Frank Smith, University of Illinois.

Abstract.

The study was undertaken for the purpose of ascertaining the distribution of the mussel fauna of the upper waters of the Vermilion River. Extensive collections were made at definite stations between Urbana and Homer Park, each station embracing a stretch of the stream measuring 500 feet or more. The water was fairly low during the 1918 season and it was possible to give the bed of the stream a most searching study. This was done either with the bare hands or with a Walker dredge for the smaller species.

Thirty-two species, representing 12 genera, were obtained. Twenty stations were established between Urbana and Middle Fork, near Danville, 12 of which were between St. Joseph and Homer Park, the part of the Salt Fork most thoroughly explored. As would be expected, the mussel fauna is the least developed in the upper part of the Salt Fork above Crystal Lake, Urbana, where but four species were found. Below the dam at Homer Park the greatest faunal development was seen, 26 species being definitely identified. The dam at this station appears to form a barrier to the migration up stream of several species, only 16 of the Homer Park mussels occurring in the stream between the dam and the neighborhood of Sidney; 10 species appear to reach their limit of upstream distribution below the dam. It is possible that the fish carrying the glochidia of these species are not able to pass the dam and do not occur above it. Next to the Homer Park station, the lower part of the Middle Fork, near Danville,

[1] Contribution from the Museum of Natural History, University of Illinois, Number 14.

gave the next highest number of species, 20. More extended search, however, may increase the number in the Middle Fork.

During the investigation it was observed that the sewage and wastes which enter the Salt Fork at Urbana, produced a marked effect upon the mussel fauna. In the ditch and Salt Fork above Urbana (Crystal Lake) four species have been identified; between Urbana and the first bridge south of St. Joseph, a distance of 14 miles by the stream, only a broken valve of *Anodonta grandis* and a single valve of *Quadrula undulata* were found. It is fair to state, however, that this portion of the stream has not been as thoroughly searched as that part below St. Joseph, and additional work may change this statement to some extent. Our observations lead us to believe, however, that no molluscan life of the Unionidae character will be found in this part of Salt Fork. Not until a point two miles below St. Joseph is reached do we find a single living mussel, *Anodontoides ferussacianus*. About a mile below the latter station the mussels become fairly abundant. In the neighborhood of Sidney, 20 miles by stream from Urbana, the mussel fauna assumes good proportions both in number of species and in individuals, a dozen species being recorded.

The most significant observation made was the sudden break in the fauna about a mile above St. Joseph. Spoon River, which is a large branch joining Salt Fork about a mile above St. Joseph, has a mussel fauna of 12 species about a mile upstream from the junction with the Salt Fork. These gradually decrease as we go down the Spoon River and cease altogether at or near the mouth. One must pass down the stream (the Salt Fork) for the distance of six miles before encountering a mussel fauna of comparable extent. These facts offer adequate evidence that the sewage and wastes affect the environment rendering it unsuited to the life of these mussels. The struggle for survival is seen in the large number of empty valves no living representatives of which could be found after careful search. It is possible that the water is diluted enough in the spring and winter to permit the mussels to migrate up stream for a considerable distance; but the concentrated condition of the sewage during low periods possibly kills those that venture up stream or perhaps causes them

to migrate down stream if the water way is open. However, no shells with the dead animals were found in our investigations and it may be that the empty shells and valves found represent beds that have been killed by the sewage in earlier years. It is possible for mussel shells to be preserved for hundreds of years, if buried in the mud or sand, and to retain the epidermis as fresh as recently living shells, and it is not at all impossible that these empty valves may represent a fauna killed several years ago by the concentration of sewage and wastes.

Detailed studies covering these and other points are now in progress and additional field work will be carried on in the fall, after which a more extensive paper will be prepared.

NOTES OF LIFE-HISTORIES OF ILLINOIS FISH.

By T. L. Hankinson, Ichthyologist, Roosevelt Wild Life Forest Experiment Station, Syracuse, N. Y.

In the progress of the field studies being made of the animal life about Charleston, Illinois, data on the life-histories of twelve species of fish have been obtained, and these will be treated in this paper together with related data obtained from literature. Little appears to be known of the life-histories of the species of fish in the region, probably because most of them are small and of little economic value. Of the seventy-two species found there, there are thirty-eight have apparently nothing definite published on their life-histories. About three-fifths of the 150 or more species of fish found in the whole State have their breeding habits and breeding habitats almost unknown to ichthyologists, although Illinois has probably had its fish fauna more thoroughly studied than any other state.

Forbes and Richardson ('09) brought together the important facts on the life-histories of Illinois fish, but since this work was written there have been some published contributions to this subject by Richardson ('13) from the Havana region; by Bertram Smith ('08) from Lake Forest; by Shelford ('11; '11a; '11b) and Hubbs ('19) and Meek and Hildebrand ('10) from the region about Chicago; and by Hankinson ('10) from the Charleston region.

Besides these notes from observations and investigations in the State, species represented in Illinois have been studied outside of the State since Forbes and Richardson's writing as shown by the following publications:—

Reighard ('10) on the Horned Dace; (10a) on the pearl organs of minnows; ('13; '15) on the Log Perch and some other species; ('14) on the common Pike; ('20) on suckers.

Reeves ('07) on the Rainbow Darter.

Kendall and Goldsborough ('08) on the Common Sucker and on a number of other species.

Kendall ('10) on catfishes; ('17) on pikes; ('18) on several species represented in Illinois.

Fowler ('12; '17; '17a) on many species, mostly minnows and suckers.

Embody ('14) growth data on several species.

Crevecœur ('08) on *Campostoma*.

Barker ('18) on the Brook Stickleback.

Jaffa ('17) on the Iowa Darter.

Shira ('17; 17a) on the Channel Cat.

Pearse, A. S., ('19) on the Black Crappie.

Hankinson ('08; '20) on a number of fish in southern Michigan, also found in Illinois.

Wright and Allen ('13) give a table with the important facts concerning the life-histories of many common species; and Gill ('07) includes a few notes on breeding of species present in Illinois. Some life-history data is given by Johnston and Stapleton ('15). In many local lists notes of value on life-histories are published. Important among these from the standpoint of Illinois ichthyology are the lists by Bensley ('15), Nash ('08), Ellis ('14), and Smith ('07).

The twelve species of fish, upon the life-histories of which the writer has obtained data through field studies chiefly in the region about Charleston, Illinois, are as follows: Chub Sucker; Common Sucker; Common Redhorse; Hogsucker; Stone-roller; Blunt-nosed Minnow; Horned Dace; Silver-mouth Minnow; River Chub; Green Sunfish, Long-eared Sunfish; and Johnny Darter.

These fish all breed in shallow parts of streams in this locality and during the spring. The breeding season for the two sunfish, the darter, the Blunt-nosed Minnow, and the River Chub extends into the summer. The sunfish appear to nest chiefly at this time, breeding as late as August. The Common Sucker, Stone-roller, and Horned

Dace were found spawning in shallow water over gravelly bottoms, in or just above riffles and always with some good retreating place like a deep pool easily accessible. Blunt-nosed Minnows, River Chubs, the two sunfish, and the Johnny Darter breed in the less rapid stream water, commonly not far from a foot in depth, and on hard bottoms, usually stony or gravelly and with little sediment.

Breeding conditions for fish in the streams of the Charleston region are very uncertain. Hard rains raise the streams rapidly and give them an intense turbidity, which is prolonged, although the water goes down quickly and leaves them in their ordinary, sluggish condition. During one of these brief freshets, a breeding area may have its character completely changed by the deposition of sediment or rubbish, by the removal of stones, gravel, and other bottom material, and often by a marked change in depth. Many eggs of these stream breeding fish are undoubtedly destroyed, since changes of this nature frequently occur at the principal spawning time in the spring.

There is considerable difference among our fish as to the way the eggs are cared for after deposition. Some, like the Common Sucker and the Silver-mouthed Minnow, drop them on unprepared bottoms. Some spawn on selected though unprepared areas and guard the eggs there, as Miss Reeves ('07) found in the case of the Rainbow Darter, where males had "holdings" commonly about fifteen inches in diameter. Some fish, like the Stone-roller and the Horned Dace and the sunfish, make structures for their eggs, and these may be called nests. In Illinois there are at least twenty species of fish known to construct nests. Some use natural cavities and depressions for their eggs and appear to do little if any building; such is the case with the Blunt-nosed Minnow* and the Johnny Darter as far as observed and probably the Channel Catfish (Shira '17a) and the Tadpole Cat, *Shilbeodes gyrinus* (Hankinson '08, p. 208).

The streams (Map, Fig. 1) where most of the field work was done are in the southeastern part of Coles County, Illinois, and belong to the Wabash system. Some observations

*Professor Jacob Reighard writes that breeding Blunt-nosed Minnows observed by him usually excavate under stones.

THIS CHART WILL BE THE FIRST CHART

APPEARING AT THE END OF THIS FILM

were made in Flat Branch, near Humboldt, Illinois. This is a tributary of the Kaskaskia River and hence is in the Mississippi drainage.

Notes on each of the twelve species of fish upon which data concerning life-histories have been obtained through field studies in the region about Charleston and other parts of Coles County, Illinois, are here given. The distribution and relative abundance of these species in this region are treated by the writer in his paper on the Distribution of the Fish in the streams about Charleston, Illinois (Hankinson '13).

Erimyzon sucetta oblongus (Mitchell), Chub Sucker.

On April 10, 1910, in Cossel Creek near Mound Cemetery, two large Chub Suckers with tuberculate snouts were seen pulling at the stones of a piece of broad, gravelly shoal. At one time these two fishes, which were in all probability males, were seen to place themselves against the sides of one of the several smaller Chub Suckers, probably females, that were associated with them. The act was very similar to the spawning act of the Common Sucker.

Little appears to be known of the breeding of the Chub Sucker. It evidently spawns early in Illinois, in March and April according to Forbes and Richardson ('09, p. 82), who found fish ready to spawn at that time. Richardson ('13, p. 410) found young more than an inch long in early June at Havana. Meek and Hilderbrand ('10, p. 252) say that the Chub Sucker spawns in April. It evidently breeds in streams, up which it may run in spring (Fowler '06, p. 162; Wright and Allen '13, table).

Catostomus commersonii (Lacepede), Common Sucker.

In the early spring this species runs up small streams for spawning purposes, chiefly at night. In Kickapoo Creek, about three miles west of Charleston, I observed the spawning activities of this species on March 31, 1910. There were about twenty of these suckers poising over a clean gravelly bottom just above riffles near a deep pool (Fig. 2). Each fish was about ten inches long and very dark colored, almost black, dorsally; and the sides were jet black. They were very different in appearance from other Common Suckers associated with them on this shoal. These were probably all or mostly females and had the ordinary coloration of the species.

Now and then two fish, evidently males, would crowd on either side of a sombre fish, very probably a female, and there would follow much bodily agitation and water disturbance. This was undoubtedly the spawning act and is like that described by Culbertson ('04, p. 65) and by Reighard ('20, p. 10). A collection of these breeding fish was made by me, and I was interested to note that on capture they lost their intense black markings instantly. Small pearl organs were found on the males taken and on two of the females in this collection; both were spawning fish with eggs streaming from their bodies.

Reighard (l. c. '04, p. 212) notes the use of pearl organs in suckers for maintaining contact of the sexes during spawning and ('20, pp. 3–15) treats in detail the breeding behavior of the species as observed in southern Michigan. Fowler ('12, p. 474) notes the distribution of these tubercles in breeding fish examined by him, but he found none in the females. Neither did Reighard ('20, p. 7).

Hypentelium nigricans (LeSueur), Hogsucker.

This species appeared to be breeding in Riley Creek about two miles west of Charleston on April 11, 1910. In a broad expanse of shallow water where the stream was about twenty feet wide and but a few inches deep, two of these fish were seen, one chasing the other and finally settling with the sides of their bodies together. They remained quietly in this way for some minutes. At another time in this same stream in a similar place two Hogsuckers were seen to take this position, but this time there were active movements of the body as in the case of the spawning Common Suckers.

Little has been found in literature on the breeding of this species. Reighard ('04, p. 212) describes the spawning act of this fish, calling it the Black Sucker ('20, p. 20) and gives an account of the sexual difference in the species and the breeding activities as noted near Ann Arbor, Michigan. Meek and Hildebrand ('10, p. 257) say that it ascends streams in the spring to spawn. Wright and Allen ('13, table) note the Hogsucker as breeding in shallows of swifter brooks in April and May.

Fig. 2. Kickapoo Creek near Charleston, Illinois, showing breeding area of Common Sucker and Stone-roller

Fig. 3. Nest of the Horned Dace

Moxostoma aureolum (LeSuer), Common Redhorse.

These fishes run up the Embarrass River in large numbers in the early spring, commonly in late March or early April, probably impelled by the breeding instinct, but they do not appear to spawn till much later, for females caught and examined at this time do not have ova that are very near maturity. Local fishermen say that they spawn about May 1 and on riffles, where many of them are easily caught by dragging clusters of hooks over the spawning beds. This way of fishing is locally called "jigging." The Redhorse is known to breed on riffles in other regions, Reighard ('14, p. 100), Hay ('94, p. 185) and McCormick ('92, p. 15), say that the Redhorse (very probably this species) spawns at such places. Reigard ('20, p. 19) describes in detail the breeding of Common Redhorse near Ann Arbor, Michigan.

Campostoma anomalum (Rafinesque), Stone-roller.

During the first warm days of early spring, usually in March but sometimes as early as February, schools of these minnows begin to move up small creeks in the Charleston region. Large numbers sometimes collect in pools below barriers, like small water falls, and over these they endeavor to jump, frequently springing a foot or more out of the water (Hankinson '10, p. 28). Sometimes they go to the extreme headwaters of these creeks where there is barely enough water to cover them and where they may be picked up easily by hand. They begin breeding in late March or early April, often some weeks after the migrations started, in water temperatures ranging from about 65° F.–80° F., according to my observations. The spawning is usually over by the middle of May in this region; the latest date recorded being May 31. The favorite breeding area is swiftly flowing shallows over fine gravel above riffles, rarely in them, with a convenient deep pool or overhanging bank for hasty retreat (Fig. 2). The fish are usually very shy at this time, making it necessary for the observer to approach very slowly and carefully, keeping out of their sight as much as possible.

The males dig pits in the gravel by pulling and pushing away stones, and according to Crevecœur ('08) by carrying pebbles up stream and dropping them. The small pearl organs that are numerous on the dorsal half of the body of

the male are used in this nest building according to Reighard ('03, p. 531). As a rule one male works at a single pit, but I have seen two digging at one and one working at two pits. The fish frequently give chase to each other, often with such heedlessness that they throw themselves out on shore and get back to water with some delay and considerable effort. They are sometimes found digging in the pit or gravel pile made by the Horned Dace. Reighard ('10, p. 1133) has also observed this, and he suspects that they eat the eggs of the Dace. Stone-rollers feed extensively and chiefly on the brown diatomaceous scum that usually covers the gravel of breeding streams, and one might easily mistake feeding for a breeding activity, but when the digging is being done by the adult males only, and Richardson '09, p. 110 and plate opp.), and when the fish without these markings associated with them are not taking part in the work, it is very likely that the operation is a breeding one. More certainty is given to the conclusion if the spawning act is observed. This takes place over a pit by a male applying himself to the side of a female or as observed in one case two males on either side of a female. The contact is maintained but for an instant. The pearl organs of the male enable him to maintain such contact, according to Reighard ('03, p. 531).

When the fish are working eggs are usually found among the stones in or about the pit by taking up a handful of the gravel and putting it in a shallow dish with a little water. The eggs sink but move about readily when the water is agitated. They are small, translucent spheres about a 1/20 inch in diameter and non-adhesive. To make the identity of these more certain, I hatched some in my laboratory and got fish eleven days old and about ⅓ inch long that showed the intestinal peculiarities of *Campostoma*. Nest building in the Stone-roller appears to be a process of bringing gravel to the surface to make a clean, scum-free bed for the eggs. The advantages of nests of this type are discussed by Reighard ('10, p. 1132).

Pimephales notatus (Rafinesque), Blunt-nosed Minnow.

This species breeds abundantly in our larger streams and to some extent in the smaller ones, there being no evident general breeding migration in this region. The eggs are placed in patches similar to those of the Johnny Darter

Fig. 4. Flat Branch near Humboldt, Ill., Nesting place of River Chub. Verfical stick marks a nest.

Fig. 5. Nest of River Chub. Thermometer five inches long used as scale.

Fig. 6. Eggs of Johnny Darter. Note: Circle used as a scale, size of a five-cent piece.

(Fig. 6) on the lower surfaces of stones or other objects that are not in close contact with the bottom giving space for the egg-laying process and for the attending male fish, that remains for the most part beneath the eggs and protects them. The breeding season appears to be a long one, my dates for finding eggs are from May 1 to August 26. Eigenmann ('96, p. 252) found eggs in Indiana during June and the greater part of July.

The eggs are most often found in shaded stretches of large creeks where the depth is about a foot and where there is a moderate current and where the bottom is rather solid with large stones on it, and these must not be firmly embedded or used as crayfish shelters. I have found eggs about Charleston in streams from 2½ to 40 feet wide, but most often where they were from 8 to 10 feet in width. Most of the stones with eggs have been in about a foot of water, but I have taken them in 18 inches. Voris ('99, p. 233) reports eggs from water as deep as two feet. My temperature readings for the breeding waters of this species have been from 70°F. to 79°F. When stones are absent or their lower surfaces unavailable, the eggs may be placed on lower sides of other objects. In this region, I have found them on tin cans, on a metal wash basin, on a half submerged barrel, on boards, pieces of bark, and once on a clod of hardpan clay. The eggs are usually placed very closely together in a roughly circular or oblong patch with longest diameter typically 4 or 5 inches; the largest observed was 10 by 4 inches. Possibly this was formed by the joining of two patches, since two or more fish frequently use the same stone. Once eight patches were found under one large broad flat stone, about four feet at its widest part. Ordinarily a surface six inches to a foot in diameter will harbor a single patch of eggs. I have found no evidence of nest building by the breeding Blunt-nosed Minnows; any excavation found may have been made by a crayfish that formerly lived under the object later used to hold the minnow eggs. Eigenmann ('96, p. 252) says the fish keeps the vicinity of its nest clean, and Professor Rieghard has made similar observations as above noted.

The parent fish watching the eggs is very dark, sometimes almost black and possesses a number of prominent pearl organs on the snout (Forbes and Richardson '09, p. 121; Fowler '12, p. 471). The fish is very probably the

male in all cases. He remains by the eggs and appears to protect them well against their ordinary enemies, for when he is removed the eggs quickly dissappear in a few cases observed. They are very probably eaten by crayfish and minnows. Once eight minnows from many that were swarming about the deserted eggs of this species were caught by me. Six were Blunt-nosed Minnows, and two Stone-rollers. No eggs could be found in the digestive tracts of these fish, however, but this may have been due to their complete mastication. At Walnut Lake, Blunt-nosed Minnows were found to be important destroyers of eggs of other species of fish (Hankinson '08, p. 204).

Semotilus atromaculatus (Mitchill). Horned Dace.

This abundant minnow in this region associates closely with the Stone-roller and like it prefers small creeks to large ones, and it breeds at about the same time and in the same kind of situation, which is a gravel shoal above riffles with a convenient place of refuge. They appear to have a breeding migration, for in the early spring, usually in late March, large individuals are abundant in the Embarrass River, and many are caught by hook then. At other times they are scarce in this stream. Shelford ('13, p. 90) notes a prominent up-stream movement for breeding. They usually spawn in April but spawning has been observed by me as late as May 15. The water in which the nests were found varied in depth from 3 to 12 inches (usually 5 or 6 inches), and its temperature ranged from 55°F. to 80°F.

The nest is made by the male fish, which is easily distinguished by the prominent pearl organs on the head and by the more or less intense flushing of red in the breast region. He is usually much larger than other fish of the species on the breeding shoal with him. In this region the nest-building males observed were from about 4 to 8 inches long. Stones are moved as in the case of the Stone-roller but in a more methodical way, since they are carried up stream and dropped in such a manner as to form a distinct ridge (Fig. 3 r.). There is a pit (Fig. 3, p.) below this ridge where the digging takes place, which forms further and further down stream as the ridge grows longer, the size of the pit remaining about the same. Reighard ('10, p. 1125) has found these ridges 16 or more feet long, but around Charleston they are seldom much more than two

feet in length. A large male eight inches long ordinarily makes ridges about two feet long and has a pit about eight inches in diameter and about two inches deep. The short ridges may be due to the swift currents produced by spring rains in the creeks where I have found the Horned Dace nests. Such currents often obliterate completely nests of this species and those of the Stone-roller, sometimes removing all the gravel there and leaving a bed of smooth clay or hardpan in its place.

As a rule, only one fish works on a piece of gravel shoal, but sometimes two are on one shoal but with nests not very near together. The nesting fish are ordinarily very wary and can be approached by taking the special precautions described in detail by Reighard ('10, p. 1113). The spawning act has been seen once by me. It was performed very quickly over the pit of the nest, and the positions of the two fish were apparently the same as those described by Reighard ('10, 1130). Eggs may be obtained and examined from the gravel of the pit or ridge by the same method suggested for the Stone-roller. Embody ('14, p. 170) advises lifting some of the gravel up in the water over the nest and allowing the eggs to be carried with the current into a fine mesh net.

Ericymba buccata Cope, Silver-mouthed Minnow.

Data on the breeding of this abundant species in this region has been obtained during one spring season, 1909, and in Campus Creek, a small stream about two miles long and draining perhaps two square miles of the region south and west of the Normal School at Charleston (Hankinson '10). They were abundant then in the stream but have been found scarce there at other times, so it is probable that they came into the creek for breeding purposes from the larger Kickapoo Creek, in which they are apparently numerous at all times. They remained in the lower half of Campus Creek and showed no tendency to go to the headwaters. Here they found a clean sandy and gravelly bottom for which they have preference (Forbes and Richardson '09, p. 158). A number of ripe fish of both sexes were caught here, April 24, 25, 26, and June 7. What appeared to be the spawning behavior was noted on April 25, 1909. A number of these Silver-mouthed Minnows were on a piece of sandy shallows where the stream was six or seven

feet wide and where the sand was thrown into many horizontal ridges or "ripple marks." Here in two or three inches of water a number of minnows of this species were chasing others of the species that were probably females. When one of these last would be overtaken it would be given a blow on the side by the pursuer. This may have effected spawning. Evidence of this was the finding of young in an aquarium over some sand gathered from beneath a place where I saw this apparent spawning take place. Evidently they hatched from eggs in this sand. Two of these fish were reared: one to a length of ¾ inch (August 5, '09) and one to 1¼ inches (December, 1909). Both were sufficiently large for positive determination.

None of the ripe fish, males or females, taken by me had pearl organs or special noticeable breeding markings of any kind. This is in accordance with the observation of Jordan ('82, p. 855), who says that the males do not undergo any special changes in color or form during the breeding season.

Hybopsis kentuckiensis (Rafinesque), River Chub.

Structures that were undoubtedly nests of this species were found in Flat Branch (Fig. 4), about two miles east of Humboldt, Illinois. These were low, round conical piles of small stones (Fig. 5), mostly from ½ inch to 1½ inches in diameter. The piles varied at their bases from about 6 by 8 inches to 10 by 20 inches and were from about 2 to 8 inches in height; this last dimension was evidently determined by the depth of the water. The fish appeared to build till the stones were near the water surface. The nests were found June 14, 1912; June 14, 1913, and May 14, 1914, but all had evidently been completed. Forbes and Richardson ('09, p. 169) give the breeding time of the species as late May and early June.

The part of the creek where the nests were found ran through a piece of pasture where there were cattle and hogs; the latter frequently roiled the water. The stream was here mostly about fifteen feet wide and shallow, almost everywhere under a foot in depth, but there were overhanging banks which gave good concealment for the nesting fish. The bottom was of firm, light-colored, mixed clay and gravel. The temperature readings made on the dates the nests were found were from 67°F. to 82°F.

Fish were not seen working on these piles, but in southern Michigan I have seen such structures constructed by large males of this species armed with pearl organs and having other breeding characteristics (Hankinson '20). There were many large male River Chubs in breeding dress in Flat Branch at the times these nests were found, and they were easily caught by scooping under the banks with a small net, and there were no other fish in the stream likely to make such stony structures. Once, one of these large male River Chubs came out to a stone pile and moved about over it, but I did not see him carry any stones. Fish eggs were found in one of the piles pulled to pieces. These were sticking to the stones and to each other in small masses. I could not be positive that these were eggs of the River Chub or some other fish that may have found such piles convenient places for eggs.

Very little has apparently been published on the life-history of this species. Reighard ('10, p. 1183) undoubtedly refers to *Hybopsis kentuckiensis* when he writes of *Hybopsis* carrying away materials from Horned Dace nests. Forbes and Richardson ('09, p. 169) say the nesting time is late May or early June 2 ('20, p. 9) describe the breeding activities of a male in southern Michigan.

This species thrives and breeds under a great variety of conditions in the Charleston region. It is abundant in large and small streams, but seems to prefer the latter, and there are large numbers in some artificial ponds including the one on the Normal School campus. It has a long breeding season here, my dates for finding nests with attending fish being from June 13 to August 23.

Two nests found in streams were in Indian Creek and Campus Creek; the first on July 1, 1907, and the other June 13, 1918. Both were shallow depressions in fine gravel; to which the eggs were attached. The nests were well out in unshaded parts of the streams conspicuously exposed without any vegetation or other concealing features near them. Each was about ten inches in diameter and in water a little less than a foot deep. This species has been found nesting in two ponds about Charleston, but in these ponds the nests were among clumps of partly submerged grass or other vegetation, and all were roughly

circular, cleaned areas about eight inches in diameter and all in a little less than a foot of water. The eggs were attached to gravel except in one case where they were on small, pea-size lumps of clay. I have found none on roots here as at Walnut Lake, in Michigan (Hankinson '08, p. 211). Hubbs ('19, p. 144), reports this species using willow roots for its eggs with no indication of a nest.

All nests found by me have been located by the presence of the attending fish over them. These have all been very similarly marked with dorsal, caudal and anal fins bordered with white and with the ventral fins nearly all white. All these nesting fish were very probably males. They stay close over the nest and show little shyness, and I have never found one defending eggs with much vigor. Hubbs ('19, p. 144) notes a nesting fish permitting itself to be handled and only gently biting at his fingers when he touched the eggs; and it took earthworms from his hands repeatedly. The sunfish that I have seen over eggs in lakes and ponds have been very well concealed by their markings. The light border of the dorsal fin is easily mistaken for a submerged grass blade or piece of rush and distracts attention from the sombre fish form below it. The spawning act was noted once and this at Indian Creek over the nest found on July 1, 1907. Here the male was about a third smaller than the female.

Very little appears to have been written on the life-history of this species. Dyche ('14, p. 115) gives a brief account of its spawning in hatchery ponds in the state of Kansas. The writer describes their nesting in Walnut Lake, Michigan (Hankinson, '08, p. 211).

Lepomis megalotis (Rafinesque), Long-eared Sunfish.

This sunfish in this region is confined almost entirely to the large streams, where it nests. Many are in the pond on the Normal School campus, and one season, 1907, they were seen nesting there, and they have undoubtedly bred there during other seasons. In the streams there is no evident migration, and the height of the breeding appears to be about the middle of June; my dates are May 25 to June 17, but they undoubtedly nest much later. In the Normal School pond, they were nesting in July and August, as late as August 23. In northern Indiana.

Kirsch ('95, p. 331) found the fish on spawning beds July 17. At Walnut Lake in Michigan, it is very certain that the fish did not begin to nest much before the middle of June in 1906.

All of the eggs of this species found in the Charleston region were attached to the stones of a gravelly nest bottom, but at Walnut Lake in Michigan rush roots were used for holding the eggs (Hankinson '08, p. 212). Broad, shaded, shallow parts of large creeks with gravelly bottom, depth under two feet and moderate current appear to be the conditions most favorable for the nesting of this species in this region. The width of the stream at the breeding site has usually been between 20 and 40 feet. In the Normal School pond nests were found a few feet out from shore in about a foot of water. Here the fish had cleaned away leaves and other bottom debris down to a gravel stratum. All nests found in the Charleston region were more or less circular areas, but they varied much in distinctness, some being almost perfectly circular and others irregular and difficult to discern and only found by the presence of the attending fish. In size they varied; some found at Polecat Creek on June 7, 1913, were about 30 inches in diameter, but ordinarily they were between a foot and two feet wide. All nests noted were very shallow depressions. The Long-eared Sunfish appears to nest always in small colonies in this region. From five to thirteen nests have been found together and from an inch or so to about a foot apart.

All nests have been located and identified by the presence of the attending fish. This was very probably the male in all cases since it always had the long opercular flap and high coloration of that sex. It appears to be especially active compared with other sunfish in protecting its eggs, especially when minnows or other creatures threaten them. I have seen the spawning act but once, and that was in the Normal School pond on July 27, 1907. Here the male and female were similar in size, each about five inches long. Forbes and Richardson ('09, p. 255) had not found a female of this species over three inches in length, and they note gravid females only 1⅝ inches long. All attending fish noted by me were from three to five inches long.

On June 17, 1910, I watched a school of minnows in a nest of this sunfish where there were eggs and where my presence kept the sunfish away. The minnows were chiefly Blunt-nosed Minnows with a few Stone-rollers and Redfins,*Notropis umbratilis atripes* (Jordan). All seemed to be devouring eggs, but observation sufficiently close to determine this was not possible except in the case of one fish, a Stone-roller, which I saw actually take in eggs.

There appears to have been very little written on the life-history of the Long-eared Sunfish. Jordan ('05, p. 15) gives a brief general account of the nesting behavior of the male, and Henshall ('03 p. 66) notes that its spawning is similar to that of the Bluegill, *Lepomis incisor* (Valenciennes).

Boleosoma nigrum (Rafinesque), Johnny Darter.

The breeding habits of this common darter are very similar to those of the Blunt-nosed Minnow in that the eggs are placed on flat under surfaces of stones (Fig. 6) or other objects, and a parent fish stays by them and protects them. Eggs have been found in both large and small streams, and it is the only darter in this region that frequents small creeks to any extent, but it appears to be in these streams in numbers only in the breeding season, so it probably has a breeding migration. I have found eggs in May and June (my dates: May 1 to June 17) in this region. Forbes and Richardson ('09, p. 295) give an earlier season, from the last of April to the first of June. At Walnut Lake, in southern Michigan, nests were found by me from May 16 to June 19 (Hankinson '08, p. 215).

All of the eggs that I have found in the Charleston region have been in shallow parts of streams with water under a foot in depth and where the current was moderate and the bottom gravelly with a few large stones or other objects for holding them. Four water temperature readings have been made close to nests, and these were from 66°F. to 77°F. At Walnut Lake, eggs were found under stones on soft white marl bottoms (Hankinson '08, p. 215). Eggs have been found on splinters, a piece of tile, and a mussel shell (l. c.). The stones used were all small, none with any diameter greater than ten inches. Beneath all these objects there has been space sufficient to permit a

free movement of the attending fish and this has been opened to the exterior, permitting the fish to move in and out. No evidence of any excavating or other nest building process by the species was obtained.

There were usually several hundred eggs packed in a layer (Fig. 6) close together in a patch, mostly in a single layer but in places in two layers. The patch is usually roughly oblong with no diameter exceeding five inches. The eggs are placed very similarly to those of the Blunt-nosed Minnow, but they are smaller and each has a conspicuous oil globule not found in the minnow's eggs. Identification has been made in every case by the presence of the attending fish, which has always been a large example of the species with much black pigment, showing especially on the dorsal part of the body and on the head, which is very dark. Jordan and Copeland ('96, p. 28) describe this pigmentation of the breeding male and say that it is a nuptial feature and disappears at the end of the breeding season. The fish watching eggs is very bold and behaves much as the Blunt-nosed Minnow does while guarding its eggs.

Forbes and Richardson ('09, p. 296) describe the spawning act in this species as it took place in an aquarium. Seal gives an account of the breeding in an aquarium of the closely related eastern form, *Boleosoma nigrum olmstedi* (Storer). He noted that the spawning was effected by the female passing up and down over the surface chosen until all the eggs were extruded and adhering to the stone. The writer made a number of observations on the nesting places and the breeding behavior of this species in Walnut Lake, Michigan (Hankinson '08, p. 215).

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PRELIMINARY SURVEY OF THE ACANTHOCEPHALA FROM FISHES OF THE ILLINOIS RIVER.*

H. J. VAN CLEAVE, UNIVERSITY OF ILLINOIS.

Life of the Illinois River has received much attention on the part of Professor S. A. Forbes and his colleagues of the State Natural History Survey. In his convincing manner Professor Forbes has strongly emphasized the intimate relationship between all forms of life in an aquatic habitat. There are few aquatic organisms which do not have some sort of interrelationship with the fishes that live in the same water. Fish as food and food for fish have been two phases of this interrelationship of organisms which have received much attention in the past. Little attention has been given to the parasites which attack the fish, though they may directly or indirectly become of considerable economic importance for the fisheries industry.

The present paper is based upon intensive examination of the fishes of the Illinois River for Acanthocephala. The entire summer of 1910 was spent at Havana, Illinois, in the study of these parasites. Additional examinations were made at various times of the year and some observations were taken at Peoria and at Beardstown. The facts thus brought together constitute the first intensive study of this important group of parasites made for any freshwater habitat in North America.[1]

The Acanthocephala comprise a group of worms which represent the development of the parasitic habit to the fullest extent. Worms of this group have become so profoundly modified in structure that the body consists of a sac for containing the reproductive organs and a special organ of attachment called the proboscis. No special sense organs, no locomotor structures, and no special organs for

*Contributions from the Laboratory of the University of Illinois, No. 152.

[1] In the interval between the reading and the publishing of this preliminary survey the full results of the investigation have been published in the Bulletin of the Illinois Natural History Survey, Vol. XIII, Art. VIII. (1919). In the meantime the results of investigations in other localities have also been published.

metabolic processes are present at any stage in the development of the individuals. They are parasitic throughout their existence. They reach maturity in the digestive tract of various vertebrates. Eggs enclosing the developing young are discharged with the feces of the vertebrate host. These embryos never are freed from their shells until they are taken into the body of some suitable primary host (usually an arthropod) in whose body they can undergo their development up to a certain stage. They never reach sexual maturity and have no power of reproduction within the body of the primary host. Development to maturity is possible only under condition that the primary host is eaten by a suitable vertebrate in whose intestine the liberated larva finds shelter and an abundant food supply to bring it to the close of its life cycle. The absolute dependence of the Acanthocephala upon some other organism throughout their entire development renders a knowledge of them of prime importance in the study of hosts which harbor them.

The effect of these parasites upon the fishes may assume several different aspects. If present in large numbers in a single host these worms appropriate elaborated food material which should be utilized by the host, thereby reducing the available food supply for the host. Frequently they are present in such large numbers that they fill the entire cavity of the alimentary canal, thereby also interfering with the digestive process. Another type of injury is that due to the action of the proboscis in its normal functioning as a holdfast organ. The proboscis is covered with hooks or spines which penetrate the lining of the alimentary canal of the host, thereby allowing the parasite to maintain its position against the peristaltic movements of the intestine. These minute spines cause lacerations and in some cases perforations of the intestine through which disease producing organisms find access to the blood system and to the body cavity of the host. Infections which under normal conditions are resisted by the unbroken mucosa of the intestine are thereby facilitated. For the reasons cited above a study of these parasites is desirable because of their direct or indirect effect upon fishes which have commercial value.

In the present study it has seemed inadvisable to attempt an analysis of percentages of infestation since in many instances the number of individuals examined was too small to render such a statement of much value. Furthermore, age of the host and season of the year when examined are factors which influence the extent of the infestation, thereby rendering any statement of percentage of infestation misleading unless a complete analysis could be given for fishes of different ages and for all seasons of the year.

In the following table is given the tabulated result of the fishes examined, showing the Acanthocephala found in each.

TABLE I.

Acanthocephala from fishes of the Illinois River at Havana

	examined	infested	species of Ac. found
Lepisosteus platostomus (Raf.) shortnosed gar	15	1	*E. thecatus*
Lepisosteus osseus (Linn.) longnosed gar	2	0	none
Amia calva Linn. freshwater dogfish	5	3	*E thecatus*
Hiodon tergisus LeS toothed herring	7	1	*E. thecatus*
Dorosoma cepedianum (LeS) gizzard shad	212*	164	*T. longirostris* *G. gracilisentis*
Anguilla chrysypa Raf. American eel	8	0	none
Ictiobus urus (Agassiz) mongrel buffalo	1	1	*P. bulbocolli*
Ictiobus bubalus (Raf.) small mouth buffalo	20	5	*E. thecatus* *P. bulbocolli*
Carpiodes carpio (Raf.) river carp	16	4	*E. thecatus* *P. bulbocolli* *N. cylindratus*
Carpiodes velifer (Raf.) quillback	1	0	none
Erimyzon sucetta oblongus (Mitch.) chubsucker	1	0	none
Moxostoma aureolum (LeS.) redhorse sucker	15	1	*O. macilentus*
Cyprinus carpio Linn. German carp	1	1	*E. thecatus* *P. bulbocolli*
Ictalurus punctatus (Raf.) channel cat	2	1	*E. thecatus*
Ameiurus nebulosus (LeS.) bullhead	3	2	*P. bulbocolli*
Ameiurus melas (Raf.) black bullhead	2	1	*P. bulbocolli*
Pomoxis annularis Raf. white crappie	6	4	*E. thecatus* *P. bulbocolli*
Pomoxis sparoides (Lacép.) black crappie	11	7	*E. thecatus* *P. bulbocolli*
Ambloplites rupestris (Raf.) rock bass	2	2	*E. thecatus*
Lepomis pallidus (Mitch.) bluegill	22	20	*E. thecatus*
Eupomotis gibbosus (Linn.) pumpkinseed	3	1	*E. thecatus*
Micropterus dolomieu Lacép. smallmouthed black bass	6	4	*E. thecatus* *N. cylindratus*
Micropterus salmoides (Lacép) largemouthed black bass	1	1	*E. thecatus*
Perca flavescens (Mitch.) yellow perch	2	1	*E. thecatus*
Aplodinotus grunniens, Raf. sheepshead	1	0	none.

*Specimens examined in all seasons of the year.

There are thus representatives of six genera of Acanthocephala infesting fish of the Illinois River at Havana: Echinorhynchus, Pomphorhynchus, Tanaorhamphus, Gracilisentis, Neoechinorhynchus, and Octospinifer. In the region under consideration each of these genera is represented by a single species. The last four of these genera belong to the family Neoechinorhynchidae, which is especially highly differentiated in the North American fauna.

Of the species of Acanthocephala infesting freshwater fishes of North America but two show strong evidence of restriction to a single host species. *Tanaorhamphus longirostris* and *Gracilisentis gracilisentis* have been recorded from the gizzard shad only. *N. cylindratus* and *O. macilentus*, though recorded for a single host species in the accompanying table, are known to occur in other species from other localities.

It is significant that no larval Acanthocephala were found in any of the vertebrates examined in the region under consideration.

In the present study four species of Acanthocephala are listed for the first time from the Illinois fauna; *Echinorhynchus thecatus* Linton, *Neoechinorhynchus cylindratus* (VanCleave), *Pomphorhynchus bulbocolli* Linkins *Octospinifer macilentus* VanCleave.

Twelve additional fish are added to the host list for *E. thecatus*, namely: *Lepisosteus platostomus, Hiodon terggisus, Ictiobus bubalus, Carpiodes carpio, Cyprinus carpio, Ictalurus punctatus, Pomoxis annularis, P. sparoides, Lepomis pallidus, Eupomotis gibbosus, Micropterus salmoides*, and *Perca flavescens*.

For *N. cylindratus* two new host species are reported: *Carpiodes carpio* and *Micropterus dolomieu*.

SUMMARY.

Over 350 fishes representing twenty-four species from the Illinois river were examined for Acanthocephala, chiefly in the summer of 1910. Of these nineteen species were found to harbor Acanthocephala.

Six genera of these parasites, each represented by a single species, were found in the fishes of the region under consideration.

But two species are restricted to a single species of host. Other species occur in widely separated Orders of fish.

E. thecatus, the most common species, was found in fourteen species of fish representing six Orders.

Two genera, Tanaorhamphus and Gracilisentis, known only from fishes of this stream, are restricted to a single species of host; namely, *Dorosoma cepedianum.*

A number of new host records are listed.

Four species are recorded for the first time from the State of Illinois.

KEYS FOR THE SEPARATION OF THE *BREMIDAE*, OR BUMBLEBEES, OF ILLINOIS, AND OTHER NOTES.

THEODORE H. FRISON, UNIVERSITY OF ILLINOIS.

The following five keys will serve for the separation of the males, queens, and workers of sixteen species of *Bremus*, and of the males and queens of four species of *Psithyrus*. These keys are not intended to represent the writer's views of our *Bremidae* phylogenetically, but are simply for the purpose of an easy identification of the Illinois species. Characters evident to the naked eye are used in the keys wherever possible, in preference to those of more obscure nature.

It has been found necessary to replace the name of *Bombidae* by that of *Bremidae* for the following reasons. The genus *Bombus* was first proposed for the bumblebees by Latreille in 1802. In 1805 *Bremus* was used by Panzer for this same group. Quite naturally, then, the term *Bombus* was at first accepted as having priority over *Bremus*. Panzer, however, writing in 1805, referred to an article by himself that was published earlier than 1805. A recent investigation has disclosed, in the library of the University of Erlangen, an article now known as the "Erlangen List." This list was published, unsigned by Panzer, its author, in May, 1801, and contained a synoptic list of the Panzer-Jurine Genera compared with the genera adopted by Latreille. In this list we find *Bremus* first used as the name for the bumblebee division of the Apidae. The discovery of this article naturally gives *Bremus* (1801) priority over *Bombus* (1802), and also explains the use of *Bremus* by Panzer in 1805. *Bremus*, however, must not be accredited to Panzer but to Jurine. It was Jurine, then living in Bern, Switzerland, who had first worked out the so-called "aary system" and had sent specimens and particulars of their "habitates" to Panzer in 1779. Panzer writing in 1801 merely published in an

expanded form the names and information sent him by Jurine. It is Jurine, then, who is responsible for *Bremus* and for certain other genera not considered in this paper. *Bremus* included both the true bumblebees and their bumblebee-like inquilines; hence the name *Psithyrus* of Lepeletier (1832) for these bumblebee-like inquilines still stands.

The writer has deemed it best, at least for the present, to follow Dr. Franklin and regard *Bombias* of Robertson (1903) as a subgenus instead of as a distinct genus. Future life history studies of the bumblebees may show that *Bombias* is really a valid genus. In a recent article (Frison, 1917) it has already been shown that the life history of *B. (Bombias) auricomus* Robt. differs widely from that of any other true *Bremus* with which I am familiar. It is thought best, however, at this time to wait until more work has been done on the life histories of our American bumblebees, before using such evidence as an aid towards a natural grouping of the *Bremidae*.

Because of the variation in the color of the pubescence of certain species of bumblebees, it has been found necessary to put such variable species in the keys in more than one place. There are several varieties of *B. rufocinctus* Cress, that have not been included in the keys, as they have only been reported from the Rocky Mountain region.

The males of the two genera of *Bremidae* may be easily separated from each other by the fact that the volsella and the squama of the genitalia of *Psithyrus* are membranous, whereas in *Bremus* they are corneous.

The outer surfaces of the hind tibiae are usually more or less covered with hairs in the males of *Psithyrus*, and in *Bremus* rather bare.

In the females, the outer surfaces of the hind tibiae of *Psithyrus* are more covered with hairs and rounded, while those of *Bremus* are more bare and flattened. In *Psithyrus* there are no workers.

The distribution of the Illinois species of bumblebees is interesting, in that Illinois represents what one might term an intermediate position. Illinois is intermediate between those states possessing the largest and those with

the smallest number of species. Many western states, with their diverse geological features, have listed nearly twenty-five species of this family, and I believe the lists will be considerably increased in the future. Florida is accredited with only four species, and all of the Gulf states appear to have a paucity of species. The writer has increased the Illinois list from ten to fifteen species of *Bremidae*, and believes the list will in time be swelled to twenty species.

Illinois has representatives of eight of the ten groups of *Bremidae* erected by Dr. Franklin and Radoszkowski. Five of the species of *Bremus (terricola, frigidus, nevadensis, borealis,* and *perplexus)* considered in these keys are here listed for Illinois for the first time. *B. frigidus* is included in the list because of the presence in the Illinois Natural History Survey Collection of specimens of this species collected in Northern Illinois by Mr. O. S. Westcott. *B. perplexus* is likewise reported from Northern Ilinois by Mr. Westcott. *B. affinis, ternarius, rufocinctus, Ps. insularius* and *ashtoni* have not as yet been taken in this state, but will probably be captured eventually in the northern part of the state. The Illinois species of bumblebees range from Lower Austral to Boreal forms. The majority of the species are principally forms that reach their greatest abundance in the Transition and Upper Austral Zones.

The distribution of the species of Psithyrus depend upon the distribution of the species of *Bremus* whose nests they infest. In Illinois I have shown that *Ps. variabilis* infests the nests of *B. pennsylvanicus* (1916). *Ps. variabilis* is therefore to be expected wherever *B. pennsylvanicus* occurs, other conditions being the same. It is not known in this country whether the same species of *Psithyrus* is an inquiline in nests of more than one species of *Bremus* or not. Sladen (1915) found *Ps. insularis* in the nest of *B. flavifrons*. *Ps. insularis* is, however, listed from regions *B. flavifrons* is not known and is not even likely to occur; indicating that *Ps. insularis* must be an inquiline in the nest of more than one species of *Bremus*. The distribution of *Ps. laboriosus* in this and other states has impressed the writer with the belief that it is an inquiline in the nests of *B. fervidus* or *B. vagans*.

Key for the Separation of the Males of the Genus *Bremus* from Illinois

1. Eyes large and bulging out from the sides of the head; ocelli large and placed well below the supra-orbital line (*Bremus*, subgn, *Bombias*) 2
—. Eyes normal, not bulging out from the sides of the head; ocelli small, placed near the supra-orbital line, and above the narrowest part of the vertex (*Bremus*) 6
2. Third antennal segment as long as the fourth and fifth segments taken together 3
—. Third antennal segment not as long as the fourth and fifth segments taken together 4
3. Sixth and seventh dorsal abdominal segments usually with ferruginous pubescence .....*nevadensis* Cress.
—. Sixth and seventh dorsal abdominal segments black..... ..... *auricomus* Robt.
4. Second dorsal abdominal segment with its basal middle covered with a tawny or dirty yellow pubescence, the remainder of the segment being black .....*separatus* Cress.
—. Second dorsal abdominal segment not so colored..... 5
5. First two dorsal abdominal segments with yellow pubescence, the remaining segments black; eyes greatly swollen and bulging out from the sides of the head; malar space a mere line .....*fraternus* F. Sm.
—. Last five dorsal abdominal segments usually with other than black pubescence; eyes somewhat swollen and bulging out from the sides of the head; malar space about one-half as long as its width at lower margin or apex..*rufocinctus* Cress.
6. Fourth to seventh dorsal abdominal segments with black pubescence dominating..... 7
—. Fourth to seventh dorsal abdominal segments not so colored... 10
7. First dorsal abdominal segment yellow, remaining segments black ..... *impatiens* Cress.
—. Dorsal abdominal segments not so colored 8
8. First two dorsal abdominal segments entirely yellow..... ..... *Vagans* F. Sm.
—. First two dorsal abdominal segments not entirely yellow 9
9. First dorsal abdominal segment, and at least the basal middle portion of the second segment, yellow....*bimaculatus* Cress.
—. First dorsal abdominal segment yellow; second segment with sides and apical margin yellow, the remainder having a tawny or dull ferruginous pubescence.....*affinis* Cress.
10. First dorsal abdominal segment, except for a very few light colored hairs, black .....*terricola* Kirby.
—. First dorsal abdominal segment not so colored 11
11. Third dorsal abdominal segment black ..... *frigidus* F. Sm.
—. Third dorsal abdominal segment not so colored 12
12. Second and third dorsal abdominal segments ferruginous ....*ternarius* Say.
Second and third dorsal abdominal segments not so colored.. 13
13. Dorsum of the thorax covered, except for a few occasional black hairs upon the disk, with yellow pubescence 14
—. Dorsum of the thorax with more or less of a decided black band between the bases of the wings 15
14. Third antennal segment as long as the fifth; occiput usually with yellow hairs dominating; malar space about as long as its width at apex; dorsal abdominal segments somewhat variable, but usually with the first three segments yellow and the remaining segments black.....*perplexus* Cress.

—. Third antennal segment shorter than the fifth; occiput usually with black hairs dominating; malar space longer than its width at apex; first five dorsal abdominal segments yellow, remaining two segments black *fervidus* subsq. *dorsalis* Cress.

15. Occiput with yellow pubescence dominant; usually a large amount of dirty white or pale yellow pubescence above the bases of the antennae; middle anterior area of the clypeus bare and glossy, with a few hairs on its anterior portion; yellow pubescence of the thorax and the abdomen a tawny yellow ..... *borealis* Kirby.

—. Occiput with black pubescence dominant; pubescence about the bases of the antennae black, or with black and light gray hairs intermixed; clypeus nearly covered over with pubescence; the yellow pubescence of the thorax and the abdomen more of bright lemon yellow 16

16. Black band between the bases of the wings usually narrow and distinct; scutellum usually well covered over with yellow pubescence; first five dorsal abdominal segments yellow, the two apical segments black; yellow pubescence usually lemon yellow in color; size medium (18-24 mm.).... *fervidus* Fabr.

—. Black band between the bases of the wings more or less indistinct; scutellum usually with a large amount of black pubescence; first four dorsal abdominal segments usually entirely yellow; apical segments black, yellow, ferruginous or with combinations of these three colors; pubescence more or less dull yellow in color; size large (22-30mm.) ..... *pennsylvanicus* DeGeer.

Key for the Separation of the Queens of the Genus *Bremus* from Illinois

1. Anterior dorsal portion of the thorax yellow, a black band between the bases of the wings; scutellum usually yellow, but sometimes completely dominated by black pubescence 2

—. Dorsum of the thorax completely yellow, except for occasional black hairs about the center of the disk 12

2. Third, fourth, fifth and sixth dorsal abdominal segments black 3

—. Third, fourth, fifth and sixth dorsal abdominal segments not entirely black 4

3. Occiput of the head bearing black pubescence, or with only a few yellow hairs intermixed; ocelli placed well below the supra-orbital line; second dorsal abdominal segment entirely yellow; of large size (20-28mm.) ..... *fraternus* F. Sm.

—. Occiput of the head bearing mostly yellow pubescence; ocelli slightly below the supra-orbital line; second dorsal abdominal segment usually with black on its side margins; of small to medium size (14-16mm.) ..... *rufocinctus* Cress.

4. The first four dorsal abdominal segments entirely yellow; fifth and sixth segments black 5

—. Dorsal abdominal segments not so colored 6

5. Occiput and face with considerable light yellowish pubescence; the middle anterior portion of the clypeus smooth and glossy ..... *borealis* Kirby.

—. Occiput and face with black pubescence; clypeus with middle portion more or less punctate, and as a rule not glossy ..... *fervidus* Fabr.

6. Second and third dorsal abdominal segments entirely yellow, first segment either yellow, black or both, remaining three segments black 7

—. Dorsal abdominal segments not entirely so colored 8
7. Ocelli placed considerably below the supra-orbital line, in the narrowest part of the front; first dorsal abdominal segment usually black; scutellum usually with yellow hairs ..... *auricomus* Robt.
—. Ocelli placed near the supra-orbital line, above the narrowest part of the front; first dorsal abdominal segment usually with some yellow pubescence; scutellum usually with a strong mixture of black hairs ..... *pennsylvanicus* DeGeer.
8. First dorsal abdominal segment entirely black..*terricola* Kirby.
—. First dorsal abdominal segment not so colored 9
9. Both second and third dorsal abdominal segments ferruginous 10
—. Second and third dorsal abdominal segments not both ferruginous 11
10. Ocelli just below the supra-orbital line; occiput usually dominantly yellow; black band between the bases of the wings more or less indistinct; fourth dorsal abdominal segment ferruginous ..... *rufocinctus* Cress.
—. Ocelli not below the supra-orbital line; occiput usually dominantly black; black band between the bases of the wings distinct and broad, with its posterior margin usually extending backward in the form of a V; fourth dorsal abdominal segment yellow .....*ternarius* Say.
11. Last two dorsal abdominal segments with black pubescence dominant; corbicular fringes black.....*rufocinctus* Cress.
—. Last two dorsal abdominal segments with a light ferruginous pubescence dominant; corbicular fringes with some ferruginous hairs.....*frigidus* F. Sm.
12. Second dorsal abdominal segment entirely black.*impatiens* Cress.
—. Second dorsal abdominal segment not entirely black..... 13
13. First dorsal abdominal segment yellow; second segment, except for a basal middle tawny patch, black; remaining segments black; ocelli placed well below the supra-orbital line ..... *separatus* Cress.
—. Dorsal abdominal segments not so colored; in some species the ocelli not below the supra-orbital line..... 14
14. First four dorsal abdominal segments yellow; fifth and sixth segments black.....*fervidus* subsp. *dorsalis* Cress.
—. Dorsal abdominal segments not so colored..... 15
15. Yellow pubescence of the pleura not extending to the bases of the legs..... 16
—. Yellow pubescence of the pleura, at least the meso-pleura, extending to the bases of the legs..... 18
16. Malar space longer than its width at lower margin; ocelli placed well below the supra-orbital line; first three dorsal abdominal segments mostly yellow, the remaining segments black.....*nevadensis* Cress.
—. Malar space not longer than its width at lower margin; ocelli not placed below the supra-orbital line, or only slightly so; first three dorsal abdominal segments not as above..... 17
17. Ocelli placed near the supra-orbital line, above the narrowest part of the vertex; malar space about as long as its width at lower margin; first two dorsal abdominal segments usually yellow, and the remaining segments black; size medium (15-21mm.).....*perplexus* Cress.
—. Ocelli placed just below the supra-orbital line; malar space shorter than its width at lower margin; second and third dorsal abdominal segments usually with some ferruginous pubescence, but the second segment sometimes with a basal median patch of yellow pubescence, the remainder of the segment being black; size small (14-16mm.) *rufocinctus* Cress.

18. First dorsal abdominal segment and a basal median patch of the second segment yellow, remainder of the pubescence of the abdomen black.....*bimaculatus* Cress.
—. Dorsal abdominal segments not so colored..... 19
19. Malar space longer than its width at apex; occiput usually with yellow pubescence dominant; sixth dorsal abdominal segment always black.....*vagans* F. Sm.
—. Malar space at the most not longer than its width at apex; occiput usually with dark pubescence dominating; sixth dorsal abdominal segment sometimes rusty colored at its tip ..... *affinis* Cress.

Key for the Separation of the Workers of the Genus *Bremus* from Illinois

1. Anterior dorsal portion of the thorax yellow; a black band between the bases of the wings; scutellum usually yellow, but sometimes completely dominated by black pubescence.... 2
—. Dorsum of the thorax completely yellow, except for occasional black hairs about the center of the disk..... 13
2. Third, fourth, fifth and sixth dorsal abdominal segments with black pubescence..... 3
—. Third, fourth, fifth and sixth dorsal abdominal segments not entirely black..... 5
3. First dorsal abdominal segment with yellow pubescence; second segment brown-ferruginous, except the sides and the apical portions, which are yellow; remaining segments mainly black .....*affinis* Cress.
—. Dorsal abdominal segments not so colored..... 4
4. Occiput bearing black pubescence, or with only a few yellow hairs intermixed; ocelli placed well below the supra-orbital line; second dorsal abdominal segment entirely yellow; medium to large size (13-22mm.).....*fraternus* F. Sm.
—. Occiput bearing mostly yellowish pubescence; ocelli not well below the supra-orbital line; second dorsal abdominal segment usually with side margins black; small size (7-14mm.) .....*rufocinctus* Cress.
5. First four dorsal abdominal segments entirely yellow; fifth and sixth segments black..... 6
—. Dorsal abdominal segments not so colored..... 7
6. Occiput and face with much light yellowish pubescence; the middle anterior portion of the clypeus smooth and glossy .....*borealis* Kirby.
—. Occiput and face with black pubescence; clypeus with its middle anterior portion more or less punctate and as a rule not glossy.....*fervidus* Fabr.
7. Second and third dorsal abdominal segments entirely yellow; first segment yellow, black or both; remaining segments black 8
—. Dorsal abdominal segments not entirely so colored..... 9
8. Ocelli placed well below the supra-orbital line, in the narrowest part of the front; first dorsal abdominal segment usually black; scutellum usually with yellow hairs..*auricomus* Robt.
—. Ocelli placed near the supra-orbital line, above the narrowest part of the front; first dorsal abdominal segment usually black, but often with yellow hairs; scutellum usually with a strong mixture of black hairs.....*pennsylvanicus* DeGeer.
9. First dorsal abdominal segment entirely black; apical segment whitish.....*terricola* Kirby.
—. First dorsal segment not so colored..... 10
10. Both second and third dorsal abdominal segments ferruginous 11

—. Second and third dorsal abdominal segments not both ferruginous 12

11. Ocelli just below the supra-orbital line; occiput usually dominantly yellow; black band between the bases of the wings more or less indistinct; fourth dorsal abdominal segment with ferruginous pubescence.....*rufocinctus* Cress.

—. Ocelli not placed below the supra-orbital line; occiput usually dominantly black; black band between the bases of the wings distinct and broad, with its posterior margin extending backward in the form of a V; fourth dorsal abdominal segment with yellow pubescence.....*ternarius* Say.

12. Last two dorsal abdominal segments with black pubescence dominant; orbicular fringes black.....*rufocinctus* Cress.

—. Last two dorsal abdominal segments with light ferruginous pubescence dominant, corbicular fringes with some ferruginous hairs.....*frigidus* F. Sm.

13. Second dorsal abdominal segment entirely black *impatiens* Cress.

—. Second dorsal abdominal segment not entirely black..... 14

14. First dorsal abdominal segment yellow; second segment, except for a basal medial tawny patch, black; remaining segments black; ocelli placed well below the supra-orbital line.....*separatus* Cress.

—. Dorsal abdominal segments not so colored; in some species the ocelli not below the supra-orbital line..... 15

15. First four dorsal abdominal segments yellow; fifth and sixth segments black.....*fervidus* subsp. *dorsalis* Cress.

—. Dorsal abdominal segments not so colored..... 16

16. Yellow pubescence of the pleura not extending to the bases of the legs..... 17

—. Yellow pubescence of the pleura, at least the mesopleura, extending to the bases of the legs..... 19

17. Malar space longer than its width at lower margin; ocelli placed well below the supra-orbital line; first three dorsal abdominal segments mostly yellow; the remaining segments black.....*nevadensis* Cress.

—. Malar space not longer than its width at lower margin; ocelli not placed below the supra-orbital line or only slightly so; first three dorsal abdominal segments not as above..... 18

18. Ocelli placed near the supra-orbital line, above the narrowest part of the vertex; malar space about as long as its width at lower margin; first two dorsal abdominal segments usually yellow, and the remaining segments black....*perplexus* Cress.

—. Ocelli placed just above the supra-orbital line; malar space shorter than its width at lower margin; second and third dorsal abdominal segments usually with some ferrguinous pubescence, but the second segment sometimes with a basal middle patch of yellow pubescence, the remainder of the segment being black.....*rufocinctus* Cress.

19. First dorsal abdominal segment and a medial basal patch of the second segment yellow; remaining segments black .....*bimaculatus* Cress.

—. Dorsal abdominal segments not so colored..... 20

20. First two dorsal abdominal segments yellow....*vagans* F. Sm.

— First dorsal abdominal segment yellow, second segment with ferruginous and yellow pubescence.....*affinis* Cress.

Key for the Separation of the Males of the Genus *Psithyrus* from Illinois.

1. Yellow pubescence of the thorax extending down on the pleura to the bases of the legs..... 2

—. Yellow pubescence of the thorax not extending down on the pleura to the bases of the legs..... 3
2. Fourth dorsal abdominal segment bearing black pubescence ..... *laboriosus* Fabr.
—. Fourth dorsal abdominal segment bearing yellow pubescence .....*insularis* F. Sm. (*consultus* Frankl.)
3. First dorsal abdominal segment bearing mostly black pubescence; fifth antennal segment longer than the third segment .....*variabilis* Cress.
—. First dorsal abdominal segment bearing mostly yellow pubescence; fifth antennal segment no longer than the third segment.....*ashtoni* Cress.

Key for the Separation of the Queens of the Genus *Psithyrus* from Illinois.

1. Occiput of the head bearing mostly black pubescence .....*ashtoni* Cress.
—. Occiput of the head bearing mostly yellow pubescence..... 2
2. Yellow pubescence of the thorax not extending far below the bases of the wings.....*variabilis* Cress.
—. Yellow pubescence of the thorax extending well down on the pleura 3
3. Dorsum of the thorax yellow, except for occasional black hairs about the center of the disk; usually with some yellow between the eyes.....*laboriosus* Fabr.
—. Dorsum of the thorax with more or less of an indistinct band between the bases of the wings, or a large number of black hairs about the disk; usually with a great deal of yellow pubescence on the uper half of the space between the eyes .....*insularis* F. Sm.

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BIRD SONGS.

ANNE WAKELY JACKSON, JACKSONVILLE.

The most neglected of our senses is undoubtedly the sense of smell; but the next in order of neglect is probably that of hearing. Verily, we have ears and hear not. The majority of us are deaf to the more delicate and elusive sounds of everyday life. We are aware of the noises, but the subtle, musical sounds escape us. However, susceptibility to agreeable sounds is not a gift, but a matter of training; and it is well worth cultivating.

So much pleasure and interest may be gained by a cultivation of the listening habit that I would urge all to whom is committed the guidance of children to do their utmost to develop this habit. It is not a difficult matter. Call the child's attention to each bell and whistle in his town or vicinity, and teach him to distinguish one from another and to name them. If he possess a musical ear he may quickly learn to determine the pitch of each one. Teach him to listen to the tones in running and falling water, in singing wires, in all the sounds made by so-called dumb animals. When his ear has become duly trained in this way he will hear the musical sounds above the noises, and a new world of enchantment will be open to him.

Bird music is one of the most fascinating departments of bird study. And like all the others, it is always offering fresh delights to the student.

Persons to whom the vocal sounds made by birds do not appeal as music may be divided roughly into two classes—the musically insensitive and the deaf, the latter class being the more numerous. These practically do not hear birds at all, or hear them with little or no discrimination. Having been almost deaf to bird sounds myself up to the time when I began to study them, it would ill become me to cavil at others in a like condition of insensibility. But anyone who overcomes this unnecessary limitation of the

senses must wonder ever after that he could have been deaf so long in the world of delightful sounds. One's ears are truly "unstopped" when one begins to cultivate the listening habit,

To the untrained ear a bird chorus offers but a jumble of sounds, somewhat like the tangle of colors seen on the wrong side of a piece of embroidery. The trained ear disentangles the various sounds and sees the pattern clearly.

It is a rare gift to be able to imitate bird notes. No instrument but the human voice can do it to perfection. The musical intervals between the notes of many bird songs are often so small and indefinite that they cannot be satisfactorily reproduced in musical notation, although attempts have been made to reproduce some of the more elusive songs. The best that can be done in such cases is merely to suggest the sound.

One might think that those persons who translate bird songs and calls into human speech are highly imaginative; but the reverse is probably the case. In reality they lack the ability to think of a bird as a complete entity, apart from its merely incidental relation to human life. In this class I would not place those writers who have used phrases of our speech as suggestive aids to the identification of bird songs. Such phrases are often a distinct help; as when Thoreau writes in his "Summer" that the country girls in Massachusetts hear the song sparrow say, "Maids, maids, maids, hang on your teakettle, teakettle, teakettle-ettle-ettle." The rhythm of "Witchery, witchery, witchery" is easy to recognize in the song of the Maryland yellow-throat, as is "Cheerily, cheerily, cheer-up, cheer-up" in that of the robin, or "Drop it, drop it, Cover-it-up, cover-it-up" in the brown thrasher's melody. Nor is it over-fanciful to name birds according to the sound of their call-notes; as the towhee (or chewink), the chickadee, the chebec, the pewee, the phoebe, etc. But with the exception of a few such callnotes, when someone tells you that such-and-such a bird *always* says so-and-so you may have your doubts. Most birds have a greater variety of calls and songs than the untrained listener would imagine.

I was once told that the meadowlark always said a certain phrase, and that if one listened for that phrase one could not fail to recognize the bird. So I listened accord-

ingly; and it took several years of attentive listening before I succeeded in hearing a meadowlark whose song remotely suggested the words given.

A bird whose song can be identified easily by words which suggest its rhythm is the white-throated sparrow. In Massachusetts it is called the Peabody bird because the natives think the bird says, "I-I-Peabody, Peabody, Peabody;" while in Maine lumbermen declare it says, "All-day-whittle-ing, whittle-ing." Just over the border in Canada the same bird sings, "Swee-eet-Canada, Canada, Canada." There is even a story to the effect that a New England farmer by the name of Peverley was in doubt one spring as to what grain to sow in a certain field. As he stood there cogitating he heard a bird sing out loud and clear, "Sow-wheat-Peverley, Peverley, Peverley, Peverley." So he sowed wheat. (Ex. 1).

The poets have done much to make bird songs real to us. I will cite but a few examples from a myriad of lovely ones. What better description of the redwinged blackbird's song than this line from Emerson: "The blackbird flutes his 'O-ka-lee!'" Or who can fail to see and hear the bluebird, spring's darling, whom Lowell describes as,

"Shifting his light load of song
From post to post along the cheerless fence."

Or that "wise thrush" (the English counterpart of our own brown thrasher) in Browning's "Home Thoughts from Abroad":

"He sings each song twice over
Lest you should think he never could recapture
The first fine careless rapture!"

What better name for the racket made by a flock of blackbirds than a "wheel-barrow chorus?"

Among our common birds there are quite a number who sing such clear and definite musical phrases that these may be easily transcribed in musical notation. Among these are the meadow lark, wood thrush, robin, tufted titmouse, Baltimore oriole, song sparrow, white-throated sparrow, wood-pewee, quail, chickadee, dove, our barn-yard friend, the rooster, etc.

EXAMPLES OF BIRD SONGS

Anne Wakely Jackson

White-throated Sparrow

Meadow Lark

Song Sparrow
8va
8va
Baltimore Oriole

In my experience the meadow lark easily heads the list in variety. I have transcribed between three and four hundred songs of this bird. His repertoire seems to be inexhaustible. Of course there are certain strains that one hears more often than others. (Ex. 2-9). Or one may hear a particular song in one key today and in another key tomorrow or next week. One may hear several variations on a particular strain. A very unusual song, because in a minor key, I heard from the same field five springs in succession. There were two variations upon this theme. (Ex. 10-12). I doubt very much if any one meadow lark always sings the same strain on all occasions, as some seem to think. I have listened to one of these birds for twenty minutes, keeping it in view all the time, and have heard it sing no less than twelve different songs during that length of time. Often two birds will sing antiphonally, answering each other from neighboring trees.

It is strange how differently bird songs affect different people. Some think the meadow lark's song "so plaintive," although it is rarely in a minor key. Others say that the dove and the wood pewee sound mournful and that the screech owl's quavering song gives them the shivers. Sounds of the joy of life, one and all. Indeed, I frequently have conversations with screech owls and find them very good company!

The song sparrow is one of the best singers of his branch of the finch family; although his song is not easy to transcribe in musical notation, owing to its greater length, more varied time, and the intermixture sometimes of rather indefinite tones. This bird is much given to embellishments, such as grace notes. Once I heard a song sparrow do what one would reasonably suppose to be an impossibility—sound two notes at once, as though one struck two piano keys, half-tones, together. (Ex. 13-16).

There is a great charm about the simple strain of the field sparrow. No matter where it is heard, the first note conjures up a vision of wide expanses of sunny meadows. The song rests the ear as a distant country view rests the eye.

The starling family, to which our blackbirds, orioles, and meadow larks belong, might be called the flute singers, as their voices have a flute-like quality. The Baltimore

oriole plays the flute proper, while the meadow lark plays the piccolo. The less conspicuous orchard oriole is a sweeter singer than his brilliant cousin, his song being more connected, as well as more delicate and lyrical. It is quite difficult to transcribe. The Baltimore is a beauty, and we love to hear him when he first returns from the south. But after a time his song grows a bit wearing. It is so insistent. The flute is necessary and lovely in the orchestra; but few of us care to listen to prolonged flute practice. One does not tire of the orchard oriole's song, however. (Ex. 17-19).

The song of the robin is rollicking and clear and definite for the most part—broken up into boisterously uttered (sometimes shrieked or yelped) fragments. (Ex. 20-22). The rosebreasted grosbeak has a lovely, smooth, musical voice, like the "divine Sarah," and its song is a delicious, melodious warble. Like its relative, the cardinal grosbeak, both male and female birds sing. Indeed, the rosebreasts are the most "advanced" birds of my acquaintance. Both parents share the duties of home-making and incubation, and their young are quite the most helpless with which I have had any experience; but that is another story! However, we have in the above biological proof of the very high state of civilization the rosebreast has reached.

Some give high praise to the song of the scarlet tanager, which somewhat resembles that of the robin and Baltimore oriole, though less musical than either. It has the acrid quality of the martin's notes. But one should not require a fine voice of a bird which, like the peacock, is so incomparably lovely.

The cardinal is one of our dearest singers. His song is as jaunty as his appearance. His most common songs are the rapidly repeated two-note phrase (the notes usually a fourth apart) and the clearly whistled "wheet-tew-tew-tew-tew" song. I once heard a cardinal sing the two-note phrase seventy times without stopping. His audience was quite out of breath long before he had finished. These two songs of the cardinal are very easy to identify, although they by no means exhaust his possibilities. He sings many variations and sometimes fools the trained listener. When in the slightest doubt about a bird song, *always see your*

20 Robin

21

22

23 Wood Thrush

24 Tufted Titmouse
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24-25
26 Chickadee
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26-27
28-29
30 Towhee
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33 Rooster
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34-35

singer to make sure. It took me four years to identify one song, that of the white-crowned sparrow. Both song and bird had long been familiar to me; but it took that long to make the very necessary connection between the two.

Undoubtedly the finest singer we have here is the wood thrush, a veritable prince of birds. His song is not long or elaborate, but in quality of tone it is peerless. Such clear, bell-like notes! Each short phrase of purest music the bird sings is followed by a curious sort of trill which cannot be indicated by notes and which wellnigh defies imitation. Sara Teasdale best describes the wood thrush's song when she says:

"I heard a wood thrush in the dusk
Twirl three notes and make a star—"

The "three notes" (sometimes four—sometimes five) are as clear and ringing as a bell, but the "star" defies transcription. (Ex. 23).

Another bird whose notes are loud and clear is the tufted titmouse, whose whistle, so it is said, has been known to fool a dog. This small bird can make himself heard a long way off. (Ex. 24-5). The unpretentious song of his kinsman, the chickadee, contains but two clear notes. The chickadees are winter residents and one hears their two-note song very early in the year. Hence people come to me in January or February to announce that the pewees are back—they "heard one today!" As pewees are flycatchers, and as flies don't usually fly so early in the season in this climate one is forced to break it to them gently that what they heard was not the call of a pewee, but the song of the chickadee. (Ex. 26-29).

The callnotes of birds are always interesting, for in these they carry on their conversations and soliloquies and express their private emotions generally. The calls used to express anxiety, fear, and sorrow are very appealing. The fear call of a brown thrasher would surely melt the heart of anyone who heard it. But who hears it? That is the trouble—we *don't* hear! One can often trace family relationships in callnotes, such as the blackbird's "chack," the redwing's "chuck," and the oriole's "check." The meadow lark and the redwing have a call of a single clear

note that is practically identical. The boat-tailed grackle has a rather musical call of "chur-dick" besides its numerous harsh squawks and calls. The rapidly repeated ground call, or cackling sound, of the meadow lark is similar to single-note calls of the family.

The callnote of the warbler family is a sharp "chick."

The native sparrows have very similar callnotes: "tseep" or "tseet" and a sharp, metallic "chink." The cardinal and the rosebreast show their relationship to the finches in their calls; that of the cardinal being a sibilant "tsip", while the rosebreast gives a bacchanalian "hip." The towhee is one of the most engaging of the finches, his callnote being his own name, which to some ears sounds like "chewink", but which is very distinctly "towhee" to me. His song is charming, sounding something like the syllables "tee-tew-pilla, willa, willa." (Ex. 30-32).

The robin and the blue jay have a great variety of callnotes and seem able to express whatever they wish, even to swear words!

Among the robin's calls are "quiddle, quiddle, quiddle, quiddle" and "quee, quee, quee, quee" or squee-ee—squee-ee," sometimes "squee-ee—squee-ee, tut, tut." He also has a rapidly repeated "tut, tut, tut, tut, tut," and a "kek-kek—kek-kek-kek."

The robin has a comical habit of singing his regular song for a while and then repeating it sotto voce in a high falsetto. One of the strangest of the blue jay's calls is that which sounds like the rattling of a handful of nuts.

The calls and songs of the flycatchers offer an interesting study; among them, the "sneeze" of the kingbird; the jolly, loud, boistrous and self-assertive calls of the great-crest, the pensive "pee-a-wee, pee-ur" of the wood pewee, and the self-named "phoebe" and "chebec."

The woodpeckers, too, offer a fertile field for study. There is the loud "pique" of the hairy and the downy which sounds like the stone-mason's chisel on the block. This callnote is sometimes rapidly repeated to make a kind of a song. Then there is the "perk" of the redhead, the cat-like snarl of the sapsucker and the "burr-rr" of the red-bellied woodpecker. The flicker, or yellowhammer, has the

greatest variety of calls and songs of any of the woodpeckers in our part of the country. He is especially eloquent and versatile during the season of courtship.

The notes of the purple martin are very attractive. He is perhaps the most ambitious of the swallows from the standpoint of song, though the tree swallow is a close second. The aerial twittering of the chimney swift is a delight to the bird-lover. There is not much music in it, but it expresses the joy of motion.

Perhaps few people know that we have a bird in this locality whose song resembles that of the far-famed European skylark. This is the horned lark, the only representative of the true larks to be found in this country. Its song is not a continuous shower of notes like that of the skylark. It is broken and fragmentary, but its notes will recall those of the skylark to one who has heard that bird beloved of poets.

The catbird has not received the recognition due to its vocal abilities. Yet it is a singer of great charm and versatility. Its contralto song is full of variety and sweetness, and is much more often heard during the singing season than the catcall from which it derives its name.

One of the most remarkable singers for its size is the kinglet. This diminutive bird pours forth a wonderfully sweet, lyrical strain. Its call is a tiny, high-pitched note. In the spring when the trees are visited by these little creatures, one would think the branches were hung with fairy bells as these tinkling notes fill the air with sparks of sound.

The mouse-like little brown creeper has a funny, creaky little callnote. And when the spring days begin to grow warm it strings its callnotes together into a creaking little song.

I shall barely touch upon the numerous warbler family, for that way lies madness. For the unleisured who long to put these elusive songs and birds together each spring brings on a fresh attack. A few of the warbler songs are quite distinctive and easily remembered. But these are the exceptions.

There are a few birds who are especially dear to us owing to the fact that they continue to sing despite the growing heat of the summer.

Among these are the house wren, the indigo bunting, and the red-eyed vireo. One may hear these brave singers on the hottest days of the year.

In a paper of this length dealing with a subject so inexhaustible, of necessity more must be left out than can be put in, and many delightful singers cannot even be mentioned. But if I have been enabled to unlock my world of enchantment to one other, my object will be attained. My own studies have been pursued, for the most part, during my walks to and from school. Of course there have been occasional excursions to the woods and fields, and certain red-letter days of discovery never to be forgotten.

There will scarcely be a day in the whole year when one may not hear a bird note. The nature lover can never be lonely out of doors with the loved voices of his brothers, the birds, greeting him by day and the faces of the friendly stars looking down at him by night. No day comes amiss. The wind is his brother and the rain his sister; and all about him are loveliness and wonder.

A goodly number of birds do not exhaust their musical enthusiasm during the love season, but save a few strains to stir up happy memories later in the year. I will close with a few lines about these,

SPRING ECHO.

Sometimes in August birds begin to sing
As though a second spring
Were come to bless the year.
For weeks perhaps we've heard but plaintive calls
And hungry fledglings' squalls
To tell us they were here.

Then suddenly some morning ripples out,
Amid the blue jay's shout,
The dear song sparrow's lay:
And straightway we forget midsummer's gone,
And nesting cares are done,
Remembering some cold day

Early in March when, wandering by the brook,
From out a brambly nook
Rang this same merry tune;
Prophetic of the days that were to be
When every bush and tree
Would shelter songsters soon.

And ere we have recovered from surprise,
We hear from out the skies
Another sound of spring:
For though we do not see their azure coats,
We catch the warbled notes
Of bluebirds on the wing.

The pewees lend their voices to the choir,
And orioles, flashing fire,
Contribute their flute notes.
And soon, above the insect voices shrill,
The air is all a-trill
With music from bird throats.

And when October lays upon each field
Her glimmering, golden shield
The meadow lark will sing
A reminiscent song,—most sweet to hear
In the departing year,—
Last echo of the spring.

Ecological Committee Report on Forestry Survey

THE FOREST LANDS OF JO DAVIESS COUNTY

H. S. Pepoon, Lake View High School, Chicago, Ill.

Preliminary Statement.

Jo Daviess county, and the adjacent parts of Stephenson county on the east and Carroll county on the south, occupying the northwest corner of Illinois, are of great interest from several viewpoints, geological, topographical, and historical. These aspects are secondary, however, in the present paper to forest conditions, and it is with this latter feature that we are concerned.

The vital importance of the woodlands in the natural economy of any region is supposedly too well known to be more than mentioned, and yet it is plain, judging by actual practices prevailing among many of our landholders, that this importance is ignored. There yet seems to be much ignorance of the part forested areas play in the amelioration of local climate, the conservation of ground-water, the vitalization of stream flow, prevention of erosion of the land, the control of floods, as harbors for bird-life, or, from the aesthetic standpoint, as adding color and beauty to the surroundings, and as a valuable resource for timber, fuel, and posts. In other, less manifest, ways their addition to the sum total of rural assets is altogether too important to be ignored in their management.

The Region in General.

Jo Daviess county and the areas adjoining it on the east and south may be briefly characterized as a very old region, geologically speaking, that has been rejuvenated by the influence of the glacial age so as to assume in many portions the aspect of extreme youth. Never covered by the continental ice-cap, it was nevertheless so surrounded by this great frozen flood that its preglacial drainage lines were so modified that new ones had to be substituted, and it is these new channels of erosion that make so pronounced an impression on the beholder.

The opinion largely prevails that the preglacial surface was a peneplain with old or mature valleys carrying off the surplus waters so that the damming influence of the glacial ice on the eastern margin changed the direction of flow of Apple River while at the same time the mighty waters resulting from the melting ice on all sides, but particularly to the north, combined to change very strikingly the ancient aspect of the surface. We find now a multitude of valleys, often with precipitous slopes, and all trending southwesterly towards the Mississippi River, with the exception of the upper course of Apple River, which follows the preglacial axis northwest to southeast. The general outcome of all this battling of the erosive powers of the past is a topography exceedingly broken up into valleys, ravines, hills, ridges, and mounds, rendering a large amount of the surface too rough for cultivation. Fully twenty per cent of the entire county is thus too steep for safe agriculture; or to express it in sq. miles and acreage, 100 sq. miles or 64,000 acres are practically untillable. All of these valleys before mentioned originally had living water courses, and while many of the larger ones yet possess streams of very erratic flow, most of the smaller drainage lines carry water only in spring or at times of especially heavy rains in winter and summer. This result, as will be shown more fully later, has been brought about by forest destruction; for it is the consensus of opinion among foresters that while forests do not in any way increase the amount or volume of water in streams, they play an important part in the fluctuation of those streams.[1]

The Soils.

There is no question that the ancient soil of this region was in the main the disintegrated rock of the three formations that underlie the surface, viz., the Niagara, Maquoketa shales, and Galena, more or less modified by plant growth (if any such existed in those remote ages), by wind action, and, along the valley drainage channels, by erosion. Such disintegration would have produced clays of various character, and remains of these ancient soils are in frequent evidence in many places where extensive weathering

[1] Diminishd Flow of Rock River in Wisconsin and Illinois and its Relation to surrounding Forests, by G. F. Schwars. Bull. 44, U. S. Forest Service, Washington, D. C., 1913.

has denuded the surface of the more recent soil additions. These clays are, as a rule, exceedingly tenacious when saturated with moisture, and almost rock-like when dry.

Fortunately for the agriculturist, this class of soils represents a very small per cent of the whole area, and, as intimated above, it is only on the more broken and steeper land surfaces that the peculiar characteristics of the clays are clearly pronounced. Here, almost without exception, the land is devoted to woodland or pasture or a combination of both, and so soil defects play very little part in the calculations of the farmer.

Loess.

The very large majority of Jo Daviess county soils are to be classed under the very much debated name of loess, which, in the language of the soil experts, signifies silts or silt loams. Briefly, some intelligent idea of how these soils originated may be obtained from the following visualization of a condition of the time during or following the glacial ice-cap stage in the Mississippi valley; a tremendous melting ice-sheet to the northward, sending down by the great glacial flood river, the Mississippi, immense quantities of debris of every sort resulting from the ice action; this flood of very variable volume, according to the intermittent character of the melting, now extending from bluff to bluff of the ancient drainage trough, and now very largely reduced, with immense flats uncovered and without vegetable cover, subjected to the desiccation of sun and wind.

Large impounded bodies of water covered much of the peneplain and of the drainage valleys, due possibly to overflows from the glacial margin into and over the driftless area. Prevailing westerly winds, presumably from altered climatic conditions more continuous and intense than any now existing, catching up great clouds of this desiccated and minutely comminuted soil of the exposed flats gradually losing their earth burden the farther they travelled away from the source of the soil, deposited a horizontal soil cone, or, rather, wedge, thick near the river margin and thinning to zero at an undetermined distance eastward. This mantle, covering hill, valley, mound, ridge, and every retaining surface and depositing in the great impounded waters a similar load to be modified by water action, is the "loess" of today.

The thickness of this loess layer varies remarkably, due in large part to the factor of later erosive extent, but is at its maximum depth along the western margin of the county, where a depth of thirty to forty feet has been recorded. At Warren, near the eastern border of the county, a depth of ten to fifteen feet is by no means a rare occurrence.

Among the physical characters of this loess or silt, there are several features that stand out very prominently, namely, the extreme degree of comminution as evidenced by the fineness of the soil particles, the lack of any pronounced "grit", the yellowish tint, the ability to withstand long periods of weathering and yet continue to assume almost vertical forms, the clay-like unctuousness and tenacity when wet and the angular and multitudinous lines of fracture when dried,—all these characters are more or less evident in all samples. Porosity is also marked in most varieties, giving, therefore, excellent soil drainage and at the same time retaining moisture, making this, in general, a superior crop soil.

Chemically it contains, as one would expect from its origin, practically all of the elements found in the lower stratified and igneous rocks. Largely composed of silicate of alumina, it contains also appreciable amounts of iron, lime, magnesia, potash, soda, and traces of many other minerals. It very commonly effervesces with acid, indicating an abundance of lime carbonate, and this presence of lime is further shown by the great luxuriance upon it of red clover, which thrives so well in a calcareous soil. An item of interest in connection with its chemical composition and the consequent relation to soil fertility is the experience of those farmers living in the lead-producing area. Abandoned, filled-up mine-shafts, which are always surrounded by an area more or less loaded with the deeper soil layers, invariably become veritable oases of crop luxuriance once the deep soil has become mixed with the original surface earth, which acts in fact better than manure because the effects are more lasting.

Soil Varieties.

From the standpoint of forest distribution, as well as that of agriculture, the soils that are of especial importance are few in number, by far the larger part of the area

under consideration having but one or more of four types of soil. In the order of their extent and influence on tree growth these soil types, are as follows: *A*, yellow silt loam; *B*, yellow-gray silt loam; *C*, the stony silt loam; *D*, brown silt loam or prairie soil; *E*. black silt loam or alluvium; *F*, rock soil; *G*, sand; *H*, black muck. The first four comprise probably 90 per cent of the soils of Jo Daviess county. Suppose that we take up a brief description of these varieties of soil, in order.

A Yellow Silt Loam.—They ellow silt loam is the extensive soil occupying most of the elevated land and slopes down to the usually abrupt declines bordering the immediate flood-plains of the streams. This soil is the chief farmland soil, and at least 50 per cent of the forest growth is found upon it. By reason of its position it is always more or less rolling or hilly, at times even abrupt, but is everywhere free from rock, usually, however, containing many flint stones of small size.

B, Yellow-Gray Silt Loam.—In a general way the yellow-gray silt loam is found on the flat summit elevations of nearly all the ridges between the lines of drainage. These flat lands are commonly called "hardpan" and are notorious for their poor drainage. It is here that all of the ancient "buffalo wallows" are found. These are circular ponds, forty to a hundred feet in diameter and from one to three feet in depth, surrounded by a fringe of marsh, caused by the buffalo of the early day standing in dense numbers and gradually stamping out a depression that became filled with water. These ponds were subsequently used as drinking-places and as a refuge in hot weather from the forest flies. So they were perpetuated until the farmer drained them, as nuisances from his point of view.

C, Stony Loam.—The stony loam occupies the steep slopes adjacent to all the larger streams, and represents the disintegrated and broken-up rock exposures, covered to a larger or smaller degree with the debris washed down from the adjacent elevated lands. The soil is usually dark and very fertile, but so full of stones of all sizes as to be totally unfit for cultivation. It is also invariably covered with timber more or less culled of better trees and, if used at all as a farm asset, is devoted to pasturage.

D, Brown Silt Loam.—The brown silt loam forms a fringe along the northeast and east margins of the region, narrowing to the west and south. It reaches a maximum width of three miles in northeastern Jo Daviess county, but extends for a number of miles into Stephenson county to the east and Wisconsin to the north. This soil is very dark by reason of its humus content and is highly fertile and almost coextensive with the drift, extending, however, on an average about two miles beyond the western margin of the same. The portion adjacent to the drift appears to have been always prairie while that portion adjacent to the yellow silt loam has been invaded by forest.

E, Black Silt Loam.—(Lintonia loam of the Dubuque soil survey.) This is the fringe of alluvium along all of the more important streams, varying from zero to a mile or more in width. Always black in color and of high fertility, this soil was originally either occupied by a heavy growth of timber or by curious narrow strips of marsh grass, resembling small prairie areas. These grasses usually occupied the very wet portions of the alluvium, and almost invariably indicated a spring or water seepage. Agriculturally this soil is the most fertile of any, but is subject always to the menace of floods.

F, Rock Soil; G, Sand; H, Black Muck.—A brief paragraph will dispose of the soils above named. The *rock soil (F)* is represented by the outcrops of the Niagara and Galena limestone. These have a vertical separation of a hundred feet or more occupied by the shales of the Maquoketa formation which do not outcrop at any point. *Sands and sandy loams (G)* are found only in the terraces of the Mississippi River and on the adjacent bluff crown. They are particularly developed in the sand prairie, a strip from one-half to two miles wide and fifteen or more miles long occupying the southwest border of the county and presenting in almost every feature the aspect of the arid western plains. These soils are coarse or fine in texture, according to their position, and are plainly river or dune formations. The *black muck (H)* soil is very limited in extent, and appears only in the bottom-lands, here and there, as undrained areas or as "quaking bogs" of limited extent and curious physical structure. The former are usually heavily wooded; the latter, never wooded.

The Forested Area.

In the days before the coming of the first farmers, the wooded area of Jo Daviess county amounted to 95 per cent of the total acreage. Practically all of the open prairie land was in the extreme northeastern portion and extended as a broad belt into Stephenson county. The demands of agriculture have continually lessened the amount of woodland until at the present time only about 15 per cent remains in timber, and even this has been depleted of all the virgin growth and thinned by successive winter chopping until the actual total amount of standing timber is not more than 5 per cent of the original stand.

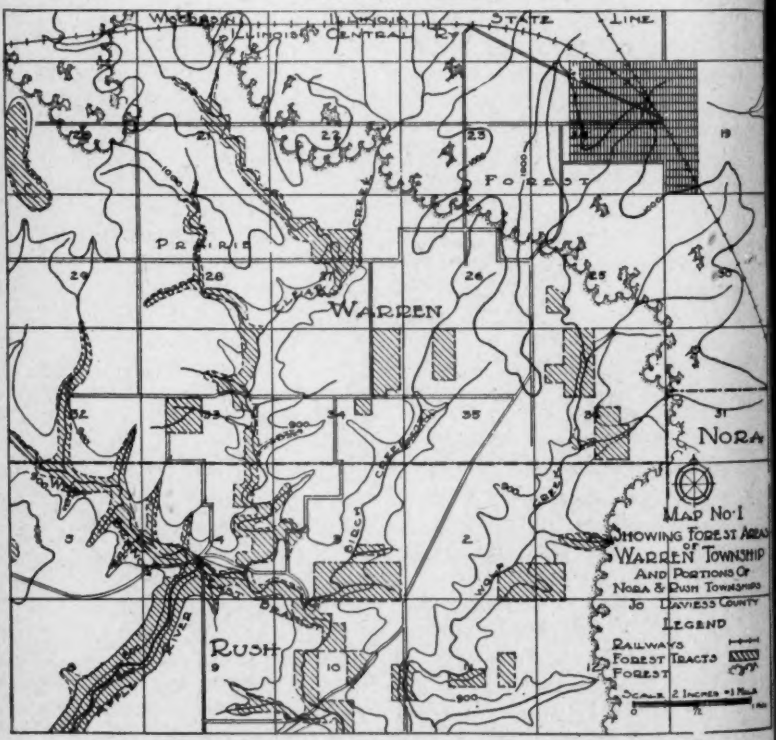
As examples of the extent to which deforestation has proceeded the following illustrations may be given (see maps for further particulars): Section 26, in Warren township, in 1850, in its south half, had not to exceed 20 acres of cleared land. By 1876 there were 150 acres in farm lands, while in 1918 there remained but 5 acres of thin woodland. Section 35, due south of Warren township, was in 1850 all timber; today 25 acres remain. Section 2, continuing south, which is rough land adjacent to a considerable stream, and likewise all timbered originally, now has possibly 30 acres of forest. Even in an exceedingly broken region like Section 4, the southwest quarter of which is shown in Map 4, nearly one-half of the acreage is cleared and cultivated.

That this clearing of the timbered slopes has been extremely prejudicial to the best interests of conservation in all its relations, may be easily conceded after one sees the numerous gullies washed in the slopes, effectually barring cultivation, seriously injuring pasture, causing a silting up of former clear and picturesque creeks and rivers, and ever recurring disastrous floods. One of the latter was of such magnitude that though only five miles in length, the stream, Clear Creek, running through the east half of Section 4, destroyed a stone mill-dam of seemingly indestructible proportions and absolutely wrecked the large flouring mill. When the escaping waters had subsided, some fifteen feet of silt was found on the bed of the pond, the result of the wash of the surrounding cultivated slopes, or expressed in another form, the equivalent of one foot of eroded soil from four square miles of farm land.

While farmers of the present day are more intelligently conducting their hill farms, there yet remains much to be desired in the conservation of the steep slopes—formerly all forest, but in many cases now deforested on the assumption that thereby much pasture is gained. And yet these same uncovered slopes, even without cultivation, often show great gullies started from some well-trodden cow-path and now assuming very threatening proportions, so that in future years, unless controlled, they will result in wreckage of valuable farm assets.

Special Examples of Forested Areas.

No 1 Map Area.



By reference to Map No. 1 the extent of the present forest areas may be seen for the township of Warren and adjacent parts of Rush and Nora townships, covering an

No. 2 Map Area.

MAP 2
SHOWING
THE
N·E·¼ OF THE S·W·¼
OF
SECTION 33,
WARREN TOWNSHIP
IN DAVIESS COUNTY, ILL.
FOREST: SECOND GROWTH
SOIL: MIAMI YELLOW SILT LOAM
SLOPE: IN GENERAL EAST
CONTOUR INTERVAL, 20 FEET
LEGEND
White Oak
Hills Oak
Bur Oak
Red Oak
Shagbark
Pignut
White Ash
Red Ash
Walnut
Aspens
Basswood
Red Elm
White Elm
Butternut
Ironwood
Black Cherry
Hard Maple
Plum
Crab
Shrubs: Hazel, Prickly Ash, Genus Rubus, Smilax, Vitis
Scale: 1 Inch Equals 10 Rods
CENTER OF SEC. 33
CULTIVATED LAND
CLEAR CREEK ¼ MILE
920
940
960
980
80 Rods
CULTIVATED LAND

area of 32 square miles. Of this area three square miles, or 9.3 per cent, is in woodlands. The region occupied by prairie is also shown by shading. In this paper, the initial chapter of the complete report, three of the wooded areas are dealt with in detail and each is illustrated by a special map and each concerns a particular phase of the forest problem. (For details not given here consult maps 2, 3, and 4.)

One thing stands out very prominently in all of the maps shown, and that is the almost universal distribution of forest upon that portion of the surface too rough for cultivation, the wooded areas being on the streams and rough hillside slopes. There are very limited areas of really good farm land still occupied by woods. This, however, emphasizes even more strongly the evident conclusion that not a desire for conservation but unsuitability for the growing farm crops has saved these remnants of forest from extermination.

No. 2 map area illustrates what may be accomplished by permitting a stand of second-growth trees to remain practically undisturbed by the woodman or by the equally dangerous grazing stock. The soil is all yellow silt loam, the exposure being in general towards the east, but with sharper slopes to north and south by reason of a forking ravine which extends almost the entire width of the woods. These secondary slopes afford excellent illustrations of the effect of topography or slope upon the distribution of tree species. The forty acres shows well hydrarch-mesophytic associations along the lower level of the ravine, xerarch-mesophytic on middle ground, and a mesotropic association on the higher portion. While there is a marked commingling of species, in the main the type species predominates.

A very striking feature of this woodland is the very large number of young oak, ash, hard maple, and to a less extent hickory, elm, basswood, and ironwood trees. Many of these seedlings have reached the height of 6 to 8 feet and are evidently well started in a successful struggle to reach maturity. This shows better than any other fact the benefit to reproduction of keeping out cattle, sheep, and hogs. From this we may say that any forest land in this area will be able to perpetuate itself if properly protected

from grazing animals. There is also the presence of many rare or fastidious herbaceous plants that will not endure any prolonged pasturing. Among these are the coral root, tway-blades, habenarias, showy orchis, yellow lady's slipper, rattlesnake plantain, shin leaf, bloodroot, drop-seed, wild ginger, bellwort, maidenhair fern, Clayton's fern, and others equally as intolerant of "civilization" as manifested in the browsing cow and rooting swine.

A more extended and careful study of the map will show well-marked topographic zones of the particular species, which we may call forest types. The high and dry summit elevations are occupied by white oak and shagbark hickory, the former almost pure stands in some places. The white oaks are 60 feet in height and from 10 to 18 inches in diameter and represent the growth of from 40 to 70 years. The original virgin white oak forest had trees from 2½ to 5 feet in diameter, 80 or more feet in height, and from 300 to 350 years of age. The writer is informed by old settlers that in those days there was very little underbrush except in moist places, and that one could ride in any direction through the timber without difficulty. Mixed with the white oak in the proportion of one in fifty is the shagbark hickory, which is always a striking tree with its bark in great loose strips. This tree is a slow grower, averaging not more than a foot in diameter in 100 years.

A zone or belt lower down than the white-oak-hickory zone is almost entirely occupied by an oak which the natives call pin oak or black-jack oak. Up to a few years ago this was called scarlet oak *(Quercus coccinea)* by botanists, but it proves to be the *Q. ellipsoidalis* of Prof. Hill. By the former names, however, it will always be known to the country folks. The upper level of this zone contains many red oaks, white oak, red ash, and an occasional wild black cherry *(Prunus scrotina)*. The largest of the pin oak trees are about 24 inches in diameter and about 60 years old. This particular belt is always considered good soil by the farmers. The red oaks are of the same average size and age. In patches of nearly pure growth in the "pin oak" zone the two native poplars are found, each attaining a height of 70 feet and a diameter of about 16 inches. The large toothed aspen *(Populus grandidentata)* is considered much more valuable than the trembling aspen *(P. tremuloides)* for construction purposes.

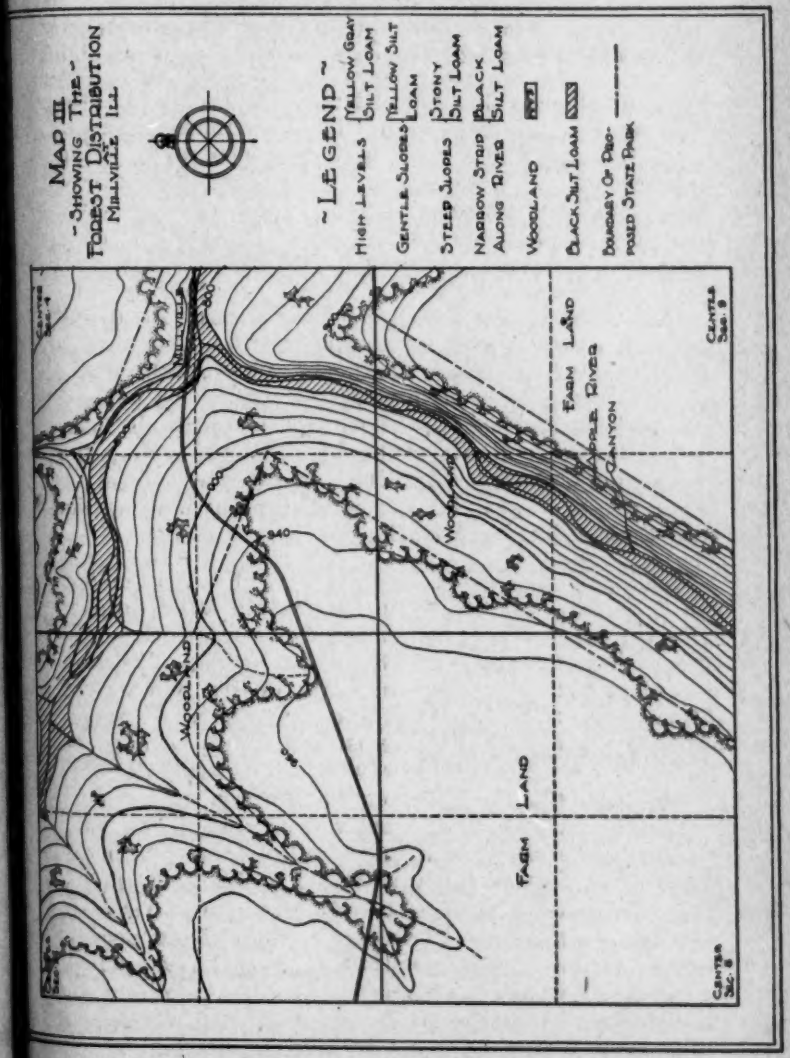
Approaching the ravines, particularly where there are abrupt slopes, a number of trees appear in rather narrow and local communities. The ironwood *(Ostrya virginiana)* seems to prefer steep north exposures and is of rare occurrence. The hard maple *(Acer saccharum)* is found covering an area 20 rods long by 10 rods wide on a gentle south slope of the south ravine. Basswood and white elm, butternut and black walnut occur along the lower level of the ravines, particularly the south one. The last named occupies a narrow alluvial strip. It is rather remarkable that this species, everywhere considered a sure sign of rich soil, grows normally in Jo Daviess county in two quite distinct sites, namely, on alluvium and on the slopes formed by the weathered Maquoketa shale. In each case the water content of the subsoil is large in amount.

This piece of timber contains by count and ocular estimate, 12,000 trees of all species, each averaging one-fifth of a cord per tree, or about 250 cords for the "forty." This is an exceedingly conservative estimate, but even this will give a stumpage value of nearly $40 per acre. As before mentioned, such land is held in high repute for farm land and practically all of this tract could be placed under cultivation. Being owned by an outsider, it has so far escaped the fate of most of this sort of land and type of forest, and stands as a fine example of what such land will produce as forest crops. Estimating the average age of this stand as 60 years, each acre has, by the interest on the forest capital, increased in value about 60 cents a year. A special use, however, of the white oak as first-class fence-post material greatly enhances the returns from that portion where white oak grows. While as cord-wood each tree is worth about $1.50, as post timber its value is about $2.50.

The prevalence of white oak on the upper level is explained by the fact that the soil is drier and more sterile as it approaches the border of an area of yellow-gray silt loam or "hardpan" land that lies just west of this woodland. Everywhere this oak signifies thin soil, by which the soil expert means that it contains a small per cent of humus which results in scanty vegetation. And here our investigation harks back to the primeval white oak forest before pictured, with a small supply of humus and an absence of underbrush and rank herbaceous plants.

In this woodland there are four well-marked strata of growth, each contributing its quota of fallen leaves and decaying stems, as follows: A—the upper story of trees,

No. 3 Map Area.



forming a closed canopy; B—an under story of young saplings or poles and of small trees such as chokecherry, plum, and crab-apple; C—the underbrush of hazel, brambles, dogwood, and the taller forest herbs; D—the ground-cover of sedges, grasses, herbs, and creeping vines. The better moisture conditions and the shade stimulate such growth, and this in decaying adds new richness to the soil.

The junction of the east and west branches of Apple River and the adjacent square mile of territory represents what is probably the roughest bit of topography in Jo Daviess county. Nearly one-half of the area is forest-covered, four of the characteristic soil types are well shown, and every possible difference in slope is found. Thus a rare opportunity is offered for correlating soil and forest types, as well as the relation of forest types to water content of soil and to deeper underlying strata. All of the area was originally timbered but most of the level land is now cultivated, while only the slopes, ravines, cliffs, bluffs, and a narrow alluvial strip along the streams are covered with timber. The higher levels have yellow- gray silt loam soil; the more gentle slopes have yellow silt loam; the steep slopes are composed entirely of stony silt loam or rock outcrops; while the narrow alluvial strip along the river is classed as black silt loam.

This highly diversified topography and the attendant soil variations result in a very interesting forest flora of markedly peculiar distribution; at the same time the deep canyon, freed from all bleak winds, and having a direction such as to receive the warmest rays of the winter sun favors the presence of some rare tree species and the vigorous development of many others. This canyon floor of alluvium, well watered and drained, shows very fine specimens of red, white, and cork elm, hackberry, walnut, butternut, red mulberry, rock maple, basswood, white ash, bur, red, white, chestnut and many other oaks, and, rarest of all, the coffee-bean *(Gymnocladus dioica)*. Within a distance of one-half mile on a strip never more than 10 rods wide, fifty species of trees are found. (See appendix for list.) The very large walnut trees have been felled and probably two-thirds of the valley timber has been removed. The land, however, is practically worthless for any purpose except for tree growth. The cutting off of

certain parts to improve the growth of pasture almost invariably results in denudation of the soil by the tremendous river floods, the standing timber, on the contrary, affording complete protection.

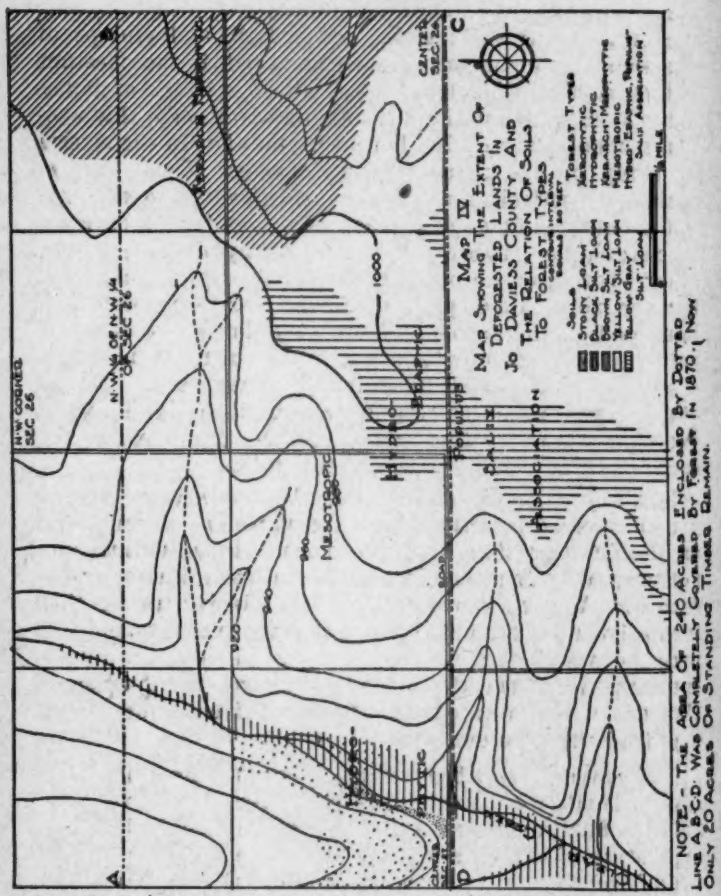
The steep slopes and even the rock exposures have a covering of many species of oak, ironwood, and shagbark hickory. A few white pines, red cedars, and clumps of basswood are common. The common oak is the chestnut oak *(Quercus muhlenbergii)*. A veritable jungle of undergrowth, shrubby and herbaceous, tends to make this canyon a botanical paradise, lessened somewhat in the esteem of many by the numerous rattlesnakes. These slopes, facing respectively southeast and northwest and removed but a few rods from each other, offer wonderful contrasts of xerophytic, mesotropic, and mesophytic associations. They show true xerophytic black oak, white pine, oak, hickory, xerarch-mesophytic red oak; hydrarch-mesophytic basswood, ending below in hackberry-elm, which may be called a mesotropic association. Some of the bald knobs are entirely occupied by xerophytic red cedar. These clumps are very marked and characteristic and are always practically free of other plant growth. The soil on all such knolls is from 75 to 90 per cent rock.

The upper gentle slopes and the more level higher ground is almost exclusively of the white-oak-hickory type on the drier portions and pin-oak-ash on the moister exposures, repeating here in a large measure the condition found in the area shown on Map 2. Nearly all of this forest, however, has been cleared and the land devoted to a precarious sort of agriculture—precarious on account of the steep slopes and the attendant danger from erosion. This entire square mile should have remained in forest and ought now to be reforested.

The canyon described offers a remarkable and very favorable site for a small state park, forest reserve, and fish and bird sanctuary, and it is to be hoped that the legislature of the state will see fit to take steps for a thorough investigation as to the suitability of this tract for such a purpose. Nearly 500 species of plants, including about 60 species of trees and as many shrubs, are here found occupying land practically worthless for any farm purpose except pasturage and a supply of fuel and post timber.

This map on a very large scale illustrates well the inroads made on the forest area by agriculture. Also by reference to its former forest cover, it shows the marked influence of soil on types of forest growth. Beginning

No. 4 Map Area.



with brown silt loam on the east, there are to be found zones and belts of yellow-gray silt loam, yellow silt loam, and black silt loam, and narrow strips of stony loam. All of the 240 acres mapped was covered with forest in 1860; now only 15 acres remain.

The eastern zone of brown silt loam was originally prairie that the forest growth had usurped. Here a splendid xerarch-mesophytic forest occupied the land and in its second-growth stage represented the passage of 60 or more years. The red oak predominated, but there was a rich intermingling of black cherry, red elm, pin oak, and yellow-bud hickory. It was pre-eminently an oak growth. On the very broad yellow-silt loam zone another forest of almost pure oak prevailed, but here, on all the drier parts, white oak predominated, and in the moister situations pin or Hill's oak occurred. The ridge summit flat of yellow-gray silt loam was very largely occupied by hazel, aspen, willows, and the open, marshy grass lands having the buffalo wallows before described. None of the trees in the yellow silt hill were over 24 inches in diameter. The growth on the flat was evidently of the Populus-Salix association, and was so because of lack of drainage, the gray silt forming hardpan.

The narrow alluvium strip along Clear Creek was very largely covered with bur oak, which everywhere in Jo Daviess county characterizes the well-drained black silts, and, as before stated, the junction of the Maquoketa and Galena formations. A plentiful supply of water is one of the evident requirements of this oak. Very typical pin oaks *(Q. ellipsoidalis* Hill*)* were rather common also and occasional yellow-bud hickories *(Carya cordiformis)*. Growing on the narrow strip of stony loam were mostly ironwood, white oak, pin oak, and shagbark hickory.

A very marked result of the deforestation of this region has been the greatly lessened surface water supply. Originally, besides Clear Creek, there were at least six minor brooks and 15 springs; today there are none. Clear Creek is only about one-fourth of its former volume and now has very high flood periods. In periods of severe drouth no soil moisture was found at times above the bedrock, which is at a depth of 20 feet below the surface, and many isolated clumps of trees had died, evidently from lack of water or lowering of the water-table. Ground-water, that formerly stood from 2 to 3 feet below the surface, is now down to a depth of 10 to 15 feet.

Conclusions.

1. Jo Daviess county was originally a forest land, and forests were encroaching on the prairies and other land at the time of settlement.

2. The original virgin timber has all been exploited.

3. About 10 to 15 per cent of the remaining forest land may be classed as heavily culled, while there is only about five per cent of merchantable timber in solid blocks. Its main use at present is for posts and fuel.

4. Most of the remaining forest occupies rough land, too steep for agriculture. By protecting this from the grazing of cattle, sheep, and hogs the forests will rapidly renew themselves.

5. A great deal of cultivated and pasture land should be reforested, since it is potentially forest land, and cutting away the forest has resulted in erosion, with all the attendant evils.

6. Practically all of the northeast slopes in the county are mesophytic or mesotropic oak associations.

7. The varieties of soil are few—over most of the area only four in number. The character of the soil not only determines the composition of species growing on it but markedly influences their growth. Forest types are closely related to soil types.

8. Jo Daviess county has some forest that should be acquired by the state as a protection forest, to conserve the water in the stream and for aesthetic and scientific purposes. Deforestation has markedly decreased the volume of water in the streams, rendering them irregular in flow and liable to floods. It has also lowered the level of ground-water from 8 to 12 feet below its former level.

APPENDIX

(Numerals refer to maps).

LIST OF TREES AND SHRUBS, JO DAVIESS COUNTY.

1. Yew *(Taxus canadensis)* III.
2. White Pine *(Pinus strobus)* III.
3. Red Cedar *(Juniperus virginiana)* III.
4. Black Willow *(Salix nigra)* II, III.
5. Peach Willow *(Salix amygdaloides)* III.
6. Shining Willow *(Salix lucida)* III.
7. White Willow *(Salix alba)* III.
8. Sand-bar Willow *(Salix longifolia)* III.
9. Pussy Willow *(Salix discolor)* II, III, IV.
10. Beak Willow *(Salix rostrata)* III.
11. Trembling Aspen *(Populus tremuloides)* II, II, IV.
12. Big Toothed Aspen *(Populus grandidentata)* II, III, IV.
13. Cottonwood *(Populus deltoides)* III.
14. Black Walnut *(Juglans nigra)* II, III.
15. Butternut *(Juglans cinerea)* II, III, IV.
16. Shagbark Hickory *(Carya ovata)* II, III.
17. Yellow-bud Hickory *(Carya cordiformis)* II, III, IV.
18. Ironwood *(Ostrya virginiana)* II, III.
19. Blue Beech *(Carpinus caroliniana)* II, III.
20. Paper Birch *(Betula papyrifera)* III.
21. White Oak *(Quercus alba)* II, III, IV.
22. Bur Oak *(Quercus macrocarpa)* II, III, IV.
23. Swamp White Oak *(Quercus bicolor)* III.
24. Chestnut Oak (Chinquapin Oak) *(Quercus muhlenbergii)* III.
25. Red Oak *(Quercus rubra)* II, III, IV.
26. Hill's Oak, (Jack Oak). *(Quercus ellipsoidalis)* II, III, IV.
27. Black Oak *(Quercus velutina)* III.
28. Red Elm—Slippery Elm *(Ulmus pubescens)* II, III, IV.
29. White Elm *(Ulmus americana)* II, III.
30. Rock Elm *(Ulmus racemosa)* III.

31. Hackberry *(Celtis occidentalis)* III.
32. Red Mulberry *(Morus rubra)* III.
33. Witch Hazel *(Hamamelis virginiana)* III.
34. Sycamore *(Platanus occidentalis).*
35. Iowa Crab *(Pyrus icensis)* III, IV.
36. Service-berry, Juneberry *(Amelanchier canadensis)* III.
37. Cockspur Thorn *(Crataegus crus-galli)* III.
38. Dotted Haw *(Crataegus punctata)* II, III.
39. Downy Haw *(Crataegus mollis)* II, III.
40. Red Haw *(Crataegus coccinea)* III.
41. Long-spine Haw *(Crataegus macracantha)* III.
42. Black Cherry *(Prunus serotina)* II, III, IV.
43. Choke-cherry *(Prunus virginiana)* II, III, IV.
44. Wild Red Cherry *(Prunus pennsylvanica)* II, III, IV.
45. Black Plum *(Prunus nigra)* II, III, IV.
46. Wild Plum *(Prunus americana)* II, III, IV.
47. Coffee-tree *(Gymnocladus dioicus)* III.
48. Honey Locust *(Gleditsia triacanthos)* III.
49. Prickly Ash *(Xanthoxylum clava-herculis)* II, III.
50. Staghorn Sumach *(Rhus typhina)* III.
51. Sugar Maple *(Acer saccharum)* II, III.
52. Black Maple *(Acer saccharum-nigrum)* III.
53. Silver Maple *(Acer saccharinum)* III.
54. Box-elder *(Acer negundo)* II, III.
55. Basswood *(Tilia americana)* II, III.
56. White Ash *(Fraxinus americana)* II, III.
57. Red Ash *(Fraxinus pennsylvanica)* II.
58. Green Ash *(Fraxinus lanceolata)* III.
59. Black Ash *(Fraxinus nigra)* III.
60. Wild Snowball *(Viburnum opulus americanum)* III.
61. Sheepberry *(Viburnum lentago)* II, III.
62. Black Haw *(Viburnum prunifolium)* III.

A PRELIMINARY REPORT ON THE NORTH TWO TIERS OF SECTIONS IN NILES TOWNSHIP, COOK COUNTY, ILLINOIS.

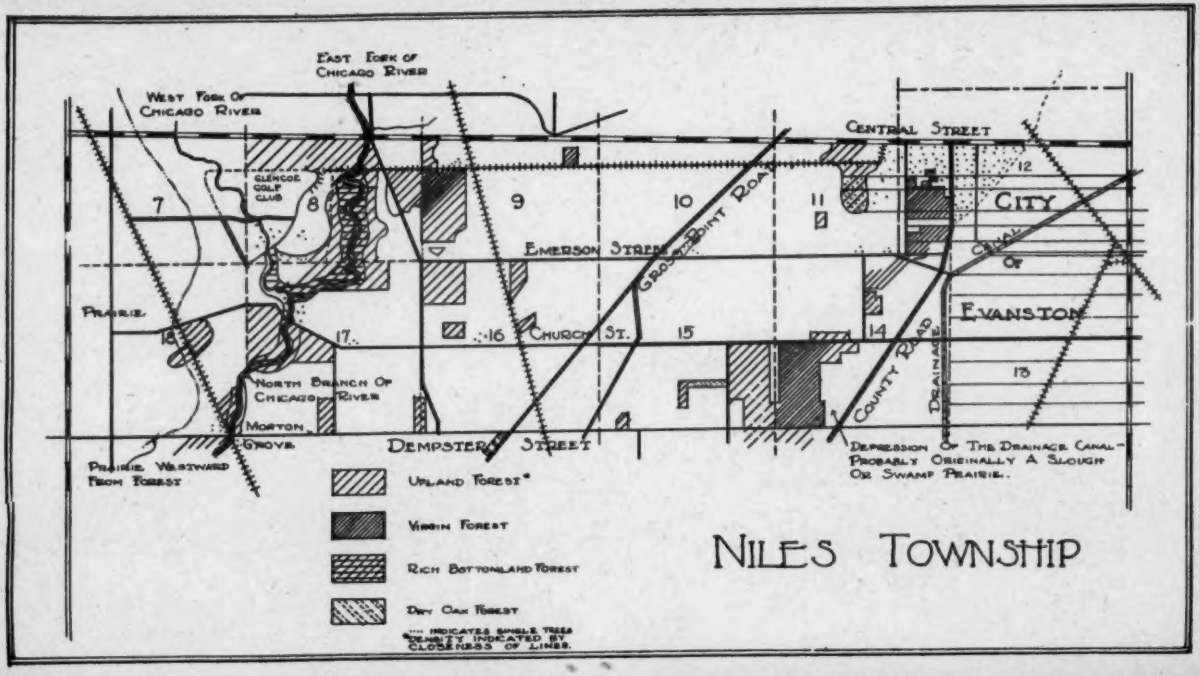
WARREN G. WATERMAN, NORTHWESTERN UNIVERSITY.

The north point of Niles Township, with the adjoining portion of the city of Evanston, begins at the north end of the Calumet and Tolleston beaches at the point where they disappear in Lake Michigan, crosses the Glenwood Beach and extends for a mile west of the Chicago river on the morainic upland. The eastern edge of the township, as shown on the accompanying map, is located in the former depression now occupied by the drainage canal, which was probably originally a swale or swamp prairie. From this swale, a swamp forest extended toward the west and its eastern edge can still be traced in a general southwesterly direction.

The north end of this forest has been included in the part of Evanston known as Lincolnwood, where many of the forest trees have been preserved in yards and along the streets, while a few patches preserve the original trees, though cleared of undergrowth and more or less pastured. One square between Colfax, Grant, Ewing, and Bennett streets, indicated by the darkest shading on the map, is either in practically the original condition or has been untouched for years.

Another patch between Church and Dempster streets of approximately 50 acres is in similarly primitive condition with a partly cut over tract of the same size adjoining it on the west.

The chief tree components of this forest are white elm *(Ulmus americana)*, swamp white oak *(Quercus bicolor)*, bur-oak *(Quercus macrocarpa)*, red oak *(Quercus rubra)*, basswood *(Tilia americana)*, soft maple *(Acer saccharinum)*, with occasional specimens of hard maple *(Acer saccharum)*, shagbark hickory *(Carya ovata)*, and butternut *(Juglans cinerea)*. The trees reach an average max-


EAST FORK OF CHICAGO RIVER
WEST FORK OF CHICAGO RIVER
GLENCOE GOLF CLUB
CENTRAL STREET
EMERSON STREET
GROSS POINT ROAD
CHURCH ST.
DEMPSTER STREET
NORTH BRANCH OF CHICAGO RIVER
MORTON GROVE
PRAIRIE
PRAIRIE WESTWARD FROM FOREST
CITY OF EVANSTON
COUNTY DRAINAGE
DEPRESSION OF THE DRAINAGE CANAL - PROBABLY ORIGINALLY A SLOUGH OR SWAMP PRAIRIE.
7
8
9
10
11
12
13
14
15
16
17
UPLAND FOREST*
VIRGIN FOREST
RICH BOTTOMLAND FOREST
DRY OAK FOREST
.... INDICATES SINGLE TREES DENSITY INDICATED BY CLOSENESS OF LINES.
NILES TOWNSHIP

imum diameter of two feet and a height of fifty to sixty feet. Lianas are abundant on the edges of the relic patches and frequently penetrate to their centers. These include bittersweet *(Celastrus scandens)*, green briar *(Smilax sp.)*, moonseed vine *(Menispermum canadense)*, virginia creeper *(Psedera quinquefolia)* and poison ivy *(Rhus toxicodendron)*. *Prickly ash (Xanthoxylum americanum)* and elder *(Sambucus canadensis)* are among the shrubs. A large part of the upland is characterized by local shallow depressions, in which the vegetation includes a considerable percentage of hydrophytic species, having swamp characteristics, such as buttressed bases.

West from the city limits the land has been largely cleared, with few single trees standing, a few woodlots and occasional clumps of second growth, but the forest apparently originally extended to the slopes of the Glenwood Beach. This beach is now occupied by the Gross Point Road with very few original trees standing and one wood lot 100 by 300 yards extending from Dempster street, southwest along the Gross Point Road. This consists chiefly of red or black oaks, with a few somewhat stunted white oak, and has the appearance of a typical sand-ridge formation. Westward to the Chicago river the substratum is composed of irregularly placed sand bars with swales and swampy spots interspersed but practically none of the forest remains, until within one-fourth or one-eighth of a mile of the river. The outlines of the forest along the river are indicated on the map and it is all included in the Cook County Forest Preserve.

The east and west branches of the north branch of the Chicago river enter the township in sections 7 and 8 and unite in the northwest corner of section 17. Contrary to the representation of the U. S. Geological Survey topographical map, the east branch is twice the size of the west. The Glenview Golf Course occupies the triangle between the two branches and only a few bits of forest remain on its grounds. North of Church street the forest has been cleared west of the river and no evidence was secured as to its original western limit. South of Church street there are patches which have been more or less pastured as far west as the line of the Chicago, Milwaukee

and St. Paul Railroad, with isolated trees even beyond that line. The river flows on a flood plain ten to fifteen feet below the upland and from one-eighth to one-fourth of a mile in width.

The upland forest consists of white oak *(Quercus alba)*, hard maple *(Acer saccharum)*, shagbark hickory *(Carya ovata)*, and white ash *(Fraxinus americana)*, with an abrupt change on the flood plain to white and slippery elms *(Ulmus americana* and *Ulmus fulva)*, soft maple basswood *(Tilia americana)*, white ash *(Fraxinus americana)*, with ironwood *(Ostrya virginiana)*, water beech *(Carpinus caroliniana)* and characteristic flood plain undergrowth.

The region surveyed includes a little over nine square miles, of which about 700 acres still bear original forest trees. Of this 700 acres, about 80 acres may be classed as primitive forest, 500 acres as open pastured forest, 100 acres as very open pastured forest and woodlots, and 20 acres primitive flood plain forest. So far there has been no attempt to correlate the forest growth with soil conditions, as the soil map of Cook county has not yet been published and there has been no opportunity of studying the unpublished data.

This region differs somewhat from the others so far studied in that it adjoins a large city, but it offers some interesting forest situations on that account. First, it shows the value of forest trees as a factor in city landscaping. The Lincoln wood portion of Evanston derives a large part of its charm from the presence of the forest trees which have been preserved as far as consistent with the mechanical necessities of laying out streets and building houses. Secondly, it shows the possibility of preserving small patches of forest in city parks and for woodlots in the midst of farms and truck gardens. Thirdly, it affords the opportunity for preserving original patches of forest in a Forest Preserve. It also emphasizes the question of the proper preservation of the forest on this preserve, where the demand for picnic grounds, as well as for pasturing, as an economic measure is already being strongly pushed. Such uses prevent reproduction of the forest and if persisted in will result not only in failure to preserve the original forest conditions, but also the inevit-

able ultimate disappearance of the forest itself. This can only be met by artificial planting, which will probably include foreign species which too often will be foreign to the natural ecological environment. While of course some of the forest preserve should be used for such purposes, other areas should be definitely set apart for preservation in as nearly the original condition as is humanly possible.

ECOLOGICAL SURVEY OF FORESTS IN THE VICINITY OF GLENCOE, ILLINOIS.

HAZEL M. SCHMOLL, UNIVERSITY OF CHICAGO.

INTRODUCTION.

The ecological survey of the forests in the vicinity of Glencoe is a portion of the Cook County Forestry Survey, which was made under the direction of Dr. Henry C. Cowles, of the University of Chicago, between October, 1918, and January, 1919.

The great number of plant associations represented in the vicinity of Glencoe may be attributed primarily to the topographical diversity of the region. The lowland, the upland, the lake bluff, and the ravines each included varying numbers of plant associations, which were determined, not only by topographical relations, but also by the variation in number and combination of certain physical factors which were peculiar to each area. This complex of factors enabled the tracing of both the hydrarch and the xerarch successions from their initial stages to their mesophytic climax.

The forest area is larger, and the forest areas that are being allowed to reproduce themselves naturally are larger than one would suspect in a region which is so thickly settled.

The northeast quarter section of land in Section 1 of New Trier Township, which is the Forest Preserve tract, that was recently purchased from W. J. Turnbull, is the largest continuous forest area in this region.

A definite terminology has been suggested by Dr. Cowles, for locating specific areas within a section of a township. For field study each section is divided up into sixteen forty-acre plots, or "forties", these being lettered alphabetically from A to P, as shown in Figure 1. Any "forty" can then be referred to by letter, as for example A, which designates the "forty" in the northeast corner of Section 1, New Trier

N. T., we would have N. T. 1, A. By numbering the 64 ten-acre plots as shown in Fig. 1, any ten-acre plot of the 64 can be designated by using the plot number after the proper capital letter, as for example N. T. 7, A 16.

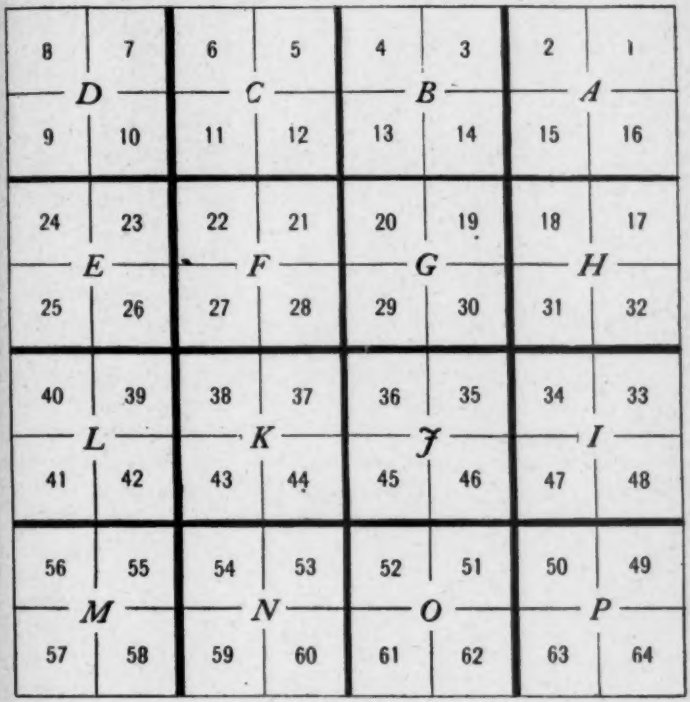


Fig. 1

I. Geography.

Glencoe is situated about sixteen miles north and west of Chicago. The particular area studied is the northern part of New Trier Township, which lies east of R. 12 E. and north of T. 42 N., and includes the following sections and parts of sections: N. T. 1 and 6, a very small portion of N. T. 5, the northern half of 7 and the portion of N. T. 8 not washed away by Lake Michigan. The boundary of this area is the Cook-Lake county line on the north, Lake Michigan to the east, South Avenue, Glencoe, on the south

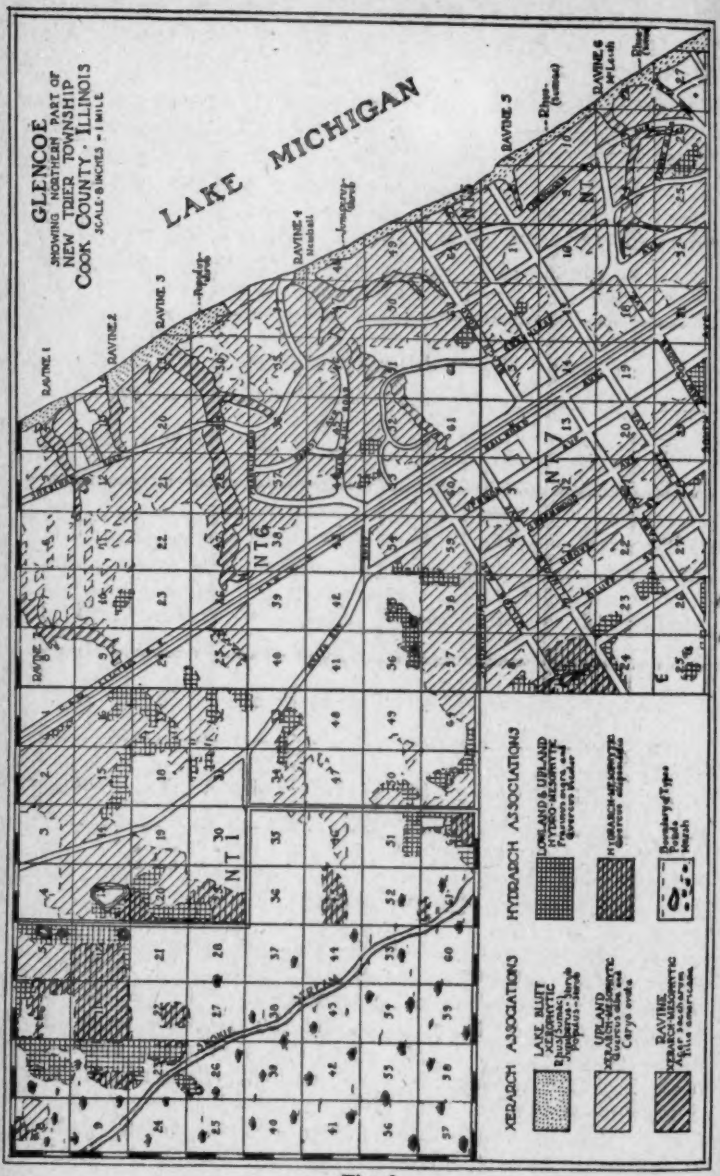

GLENCOE
SHOWING NORTHERN PART OF
NEW TRIER TOWNSHIP
COOK COUNTY · ILLINOIS
SCALE 6 INCHES = 1 MILE
LAKE MICHIGAN
RAVINE 1
RAVINE 2
RAVINE 3
RAVINE 4
RAVINE 5
RAVINE 6
NT1
NT6
NT7
XERARCH ASSOCIATIONS
HYDRARCH ASSOCIATIONS
LAKE BLUFF
LOWLAND & UPLAND
UPLAND
HYDRARCH-MESARCHIC
RAVINE

Fig. 2

and Northfield Township and the northeast quarter of Section 12, New Trier Township to the west. (See Fig. 2.)

Section 1 of Northfield Township is incorporated in New Trier Township, hence, since there is no Section 1 of New Trier Township, Northfield 1 will be designated as New Trier 1. The map of Glencoe recently made by Windes and Marsh has been used in this survey. The dotted line to the east of this area, as seen in Fig. 2A, represents the topography as mapped by the State Geological Survey of the State of Illinois many years ago.

II. Physiography.

A. Geology.

This area lies at about the center of what the geologist calls the "Evanston-Waukegan" region. It includes the depression and the ridge at the most easterly edge of the Valparaiso moraine. At this point it is composed of unstratified glacial drift over-lying Niagara limestone. This drift is made up of a heterogeneous mixture of material which is comprised of clay, sand, gravel, unweathered pieces of rock, pebbles, cobblestones, and boulders.

B. Physical Geography.

The glacial drift forms a ridge (discussed as the upland) which is from a mile to a mile and a quarter in width; which extends in a northwest and southeast direction paralleling Lake Michigan; and which is from sixty to eighty feet above the lake level. The glacial origin and soil composition of the region account for the elevations and depressions of both the upland and the lowland. The slope of the ridge facing the lake is, on the whole, very steep, whereas, the slope to the lowland on the west is a very gradual one. The lowland lying parallel to the ridge is known as the Skokie Swamp. This swamp was naturally undrained, but the swamp is now ultimately drained by a ditch which connects the Skokie Stream with the East Fork of the North Branch of the Chicago River.

C. Topography.

Both the pre-erosion and erosion types of topography are represented in this region. The former embraces the upland and its slope to the west, the lowland of the Skokie, and the stable portion of the ravines; the latter includes the eroding lake bluff, and the head and mouth of the ravines.

III. Plant Successions.

Even the most casual survey of the region reveals how much the grouping of certain plants into associations is dependent upon the topography. The predominance of secondary forest associations, and the present state of progression or retrogression of these lowland or upland forests has been occasioned by man's influence. The agencies which have done most to bring about this condition are cutting, grazing, burning and drainage.

Ample illustrations of pioneer and subsequent associations of both hydrarch and xerarch successions are to be found within a very narrow strip of territory extending from Lake Michigan on the east to the Skokie Stream on the west. The hydrarch succession has its best expression in the Skokie region and is well, but less completely represented in the depressions of the upland; the xerarch succession was represented in the upland, the lake bluff, and the ravine.

A. The Hydrarch Succession.

1. The Lowland-Skokie.

The topography of the lowland consists of a series of slight elevations and depressions. In its natural condition the lowest part of this area was an undrained swamp of considerable size. By means of an artificial drainage system, man has found it possible to reclaim large tracts of this land for agricultural purposes.

a. The unforested area.—The most poorly drained land of the Skokie is unforested. Here are to be found what Sherff calls the reed swamp, the meadow swamp, and the shrub associations. More than two-thirds of the western half of New Trier 1 occupies this area. (See un-

Fig. 3

forested area of map). The effective drainage of the swamp has, no doubt, been the chief factor in allowing the extension of the meadow swamp, which has become the hay land of this region.

Sherff states that under natural conditions the shrub association would occupy an intermediate place between the swamp meadow or the reed swamp associations and the forest. Most of the shrubs and young trees bordering the Skokie have been killed by the burning over of hay land by many farmers in the late autumn. This would account for the forests rising abruptly from the reed swamp or meadow swamp associations, and also for the recent inability of the forest to encroach upon the better drained areas.

A reed swamp, in an embayment from the main part of the unforested Skokie area, in N. T. 1, 10 was the only place where a complete and definite shrub association was found bordering the Skokie (See Figs. 1, 2, and map). *Cornus stolonifera, Cornus amomum, Salix discolor, Salix* (sp.), *Sambucus canadensis* and *Viburnum lentago* formed a definite zone between the swamp and the forest. These same shrubs were found at the north end of the island in N. T. 1, 23 and 26.

b. The forested area.—The hydrarch succession of the lowland is represented by two forest associations—the hydro-mesophytic and the hydrarch mesophytic. The former association, as will be seen in Fig. 3, usually forms a zone about the shrub or swamp associations and is characteristic of the wettest part of depressions where trees will grow; the latter association is found in the better drained area adjoining the hydro-mesophytic association. This succession probably reaches its fullest expression in the lowland, but it is also found in depressions of the upland.

The lowland area interpreted three ecological facts very well. First, it exemplified how certain factors check the progressive development of forests toward the mesophytic climax forest of the region; second, how other factors hasten the development of pioneer associations toward the mesophytic climax forest of the region; third, how readily a forest association can be determined by the amount of available soil moisture.

The forests in this region are all second growth. The primary factors which caused retrogression were fire, cutting and grazing. Aside from the checking of the advance of the forest upon the Skokie region, fire destroyed the dead leaves, thereby preventing the building up of the land and the development of a more mesophytic vegetation. The effect of cutting varied. Where an area was clear cut, the period of recovery has been a long one. In areas where only the larger trees were removed, practically the original type of forest was preserved, if the undergrowth was allowed to remain. The pasturing of woods, next to clear cutting, was probably one of the most retrogressive agencies in this region, because it prevented the reproduction of the forest. Observation seemed to indicate that drainage in the region of the hydrarch succession would, if done gradually, hasten the development of the forest toward the mesophitic climax.

(1) Hydro-mesophytic association.—The area best illustrating the hydro-mesophytic forest was the low swampy depression in N. T. 1, 13 and N. T. 1, 5 and 12. There was one large pond in N. T. 1, 13 and several small ones in N. T. 1, 5 and 12. It is the area to the west of this larger pond which concerns us in the study of the early phases of the hydrarch succession. The slope to the east of the pond was steep and the upland forest came to the very edge of the pond. In October there were a few inches of water in the pond and the growth of aquatic plants in it was quite dense. In the more shallow parts of the pond and toward the outer edge to the west were the reed swamp and the shrub associations. The shrubs found were those typical of undrained depressions, *Cephalanthus occidentalis, Salix discolor, Salix* (sp.), *Rosa carolina* and *Viburnum lentago.* These shrubs were the same as those bordering the Skokie. Immediately succeeding the shrubs and forming a border about the west edge of the pond was the forest association represented by *Fraxinus nigra,* and *Fraxinus pennsylvanica.* Continuing on the area, rising in places above the level of the swampy area, and west from these were *Quercus bicolor, Ulmus americana, Fraxinus americana, Quercus macrocarpa, Quercus ellipsoidalis, etc.* In every case, whether it was in the depressions of the upland, or the lowland, these trees occurred in the same order in relation to the amount of available water.

The relative abundance of Quercus bicolor in the upland, of the northern and central part of N. T. 7, and the southern part of N. T. 6, seems to indicate the previous existence of a great many depressions in this region, some of which must have been of considerable extent. This region lies in the most thickly settled portion of Glencoe. Man has filled in many of the depressions of this area; hence, one is led to suspect that the only means of determining their natural existence is through a study of the older trees which comprise the forest here.

Between Park Avenue and South Avenue, Railroad Avenue and Grove Street there are very few trees, but they are the largest trees, as a group, which were found in this region. They averaged twenty to twenty-four inches in diameter. There is an area of about thirty acres between Hazel Avenue and South Avenue in which *Quercus bicolor* and *Quercus macrocarpa* are the dominant trees. A few trees of *Fraxinus nigra* were also found with these. Adjoining and over-lapping this area were found *Ulmus americana, Fraxinus americana, Quercus ellipsoidalis, Quercus rubra, Prunus serotina, Pyrus coronaria,* and *Acer saccharum.* While *Quercus macrocarpa* was found abundantly in the hydro-mesophytic areas, it was also found on th mesophytic upland, but here in less abundance.

(2) The hydrarch mesophytic association—The transition from the hydro-mesophytic to the hydrarch mesophytic forest was, in almost every instance, clearly defined. A higher elevation and a better drainage of the land in these cases accompanied the change in forest associations. In mapping the hydrarch mesophytic areas no attempt has been made to separate the hydrarch mesophytic forest proper from the transition type, which lies between this forest and the upland hydrarch mesophytic climax forest.

The extremely varied aspect of the hydrarch mesophytic forest in this region is due to the interference of man.

The typical tree species in the order of their importance found in the hydrarch mesophytic woods were *Quercus ellipsoidalis, Quercus macrocarpa, Carya cordiformis, Juglans nigra, Ulmus americana, Quercus rubra, Prunus*

secrotina, Carya ovata, Acer saccharum, Populus deltoides, Tilia americana, and *Quercus alba,* in the upper *ellipsoidalis, Quercus macrocarpa, Carya cordiformis, Crataegus* (sp.), *Prunus americana, Prunus nigra,* and *Pyrus coronaria* in the lower stratum. The shrubs occurring here were *Hamamelis virginiana, Sambucus canadensis, Evonymus atropurpureus, Virburnum lentago, Viburnum acerifolium, Cornus stolonifera, Cornus paniculata, Ribes cynosbati, Ribes floridum, and Corylus americana.* Among the vines present were *Vitis* (sp.), *Smilax hispida, Celastrus scandens, Lonicera Glaucescens. Quercus ellipsoidalis,* although variable in the abundance in which it occurs, was the most characteristic tree of this association. In places it formed pure stands. The tree in Fig. 4 is a specimen of *Quercus ellipsoidalis,* var. *coronaria.*

The stand of trees in N. T. 1, C was quite dense. *Quercus ellipsoidalis, Quercus rubra* and *Ostrya virginiana* were the dominant trees here. Other trees were *Juglans nigra, Carya cordiformis, Tilia americana,* and *Fraxinus americana.* There were very few specimens of shrubs in the undergrowth. *Sambucus canadensis* was the most abundant shrub. A few specimens of *Rubus occidentalis,* and *Virburnum ascerifolium,* and but one specimen of *Evonymus atropurpurea* were found. The herbaceous undergrowth represented a high type of mesophytism. *Osmorhiza* (sp.), and *Hepatica acutiloba* were taken as the mesophytic indicators.

The entire forest in N. T. 1, C had been cut over. It seemed obvious that only the larger trees in N. T. 1, 12 had been cut out, for trees from eight to twelve inches in diameter were abundant. The smaller trees of from two to six inches in diameter were of the upland mesophytic type. This upland type was represented by *Quercus alba, Carya ovata,* and *Acer saccharum.* Except for these latter trees the forest was not reproducing itself.

The forest in N. T. 1, 11 had evidently been more recently and more thoroughly cut over. Aside from a very few trees which were from eight to sixteen inches in diameter, the trees were only from one to six inches in diameter.

Fig. 4

The hydrarch mesophytic forests in N. T. 1, D and E differed in aspect considerably from those in N. T. 1, C. This difference was not due entirely to the presence of a few additional tree species, but to the abundance and more varied representation of growth forms, i. e., trees, shrubs, vines and herbs. Except for a few large trees, about two feet in diameter, and mostly all of which were elms, at the very edge of this type of forest, the trees were practically all less than six inches in diameter.

Along the edge of the forest bordering the Skokie swamp in N. T. 1, 10 the dominant tree was *Populus grandidentata.* It and *Populus tremuloides* were found, although less abundantly, at the edge of the forest wherever it bordered the Skokie. The shrubs and vines found here were the same as those enumerated above.

The islands in N. T. 1, D and E of the Skokie were of special interest. The first problem which confronts one is, why, or how can forests exist in these places which are somewhat isolated from the main forest body; the second, how does the vegetation compare with that of the main forest. First, it was found that these islands were areas that were slightly elevated above the surrounding swamp, and that the density of the vegetation indicated continued rise of the land due to the accumulation of humus. Second, the upper stratum of trees was the same as that in the main forest, but the dominant members of the lower stratum of trees in general were of a more xerophytic type than those found in the larger forests. *Populus tremuloides,* a northern outlier and xerophyte, was abundant along the more exposed western edge of the islands as well as along this edge of the main forest.

The island in N. T. 1, 23 and 26 merged gently from the reed swamp of the Skokie at its northern end, and rose to a height of a couple of feet above it at the southern end. The reed swamp association at the north end of the island was followed by the orthodox shrub association to the south, and was succeeded in that same direction by trees of the hydro-mesophytic association to about the center of the island, and then by those of the hydrarch mesophytic association at the southern part of the island. With the exception of a few large trees of *Ulmus americana,* about two feet in diameter, at the northern end of

the island, all of the trees were small, probably averaging about four inches in diameter. *Fraxinus nigra* has developed as coppice, and *Quercus bicolor* occurs as a small tree. These were the three dominant tree species comprising the hydro-mesophytic association. *Quercus ellipsoidalis* was the dominant tree of the more mesophytic portion of the island. The pioneer xerophyte, *Pyrus coronaria,* was the most abundant member of the trees in the lower stratum. The extremely dense undergrowth is comprised largely of the trees of the lower stratum, and vines. The latter were represented by all of the different species noted in the plant list for the hydrarch mesophytic association. The herbaceous undergrowth indicated a high degree of mesophytism.

The island in N. T. 1, 8 presented an entirely different aspect from the one in N. T. 1, 23 and 26. It was elevated somewhat higher above the Skokie than the one just described. The cutting here had evidently been more severe, because there were no large trees on the entire island. The dominant vegetation was shrubs. These formed almost a pure stand, entirely excluding trees from the northern end of the island. *Rhus typhina* and *Rhus glabra* occupied a narrow zone to the north and west end of the island. The remainder of the island was covered with a thicket of *Corylus americana* and *Hamamelis virginiana* about 12 feet in height which was almost impenetrable. Of these two *Corylus americana* was the most abundant. Shrubs fewer in number and importance found near the edge of this mass were *Rosa* (sp.), *Rubus occidentalis* and *Physocarpus opulifolius.* The tree species listed were *Quercus ellipsoidalis, Quercus rubra, Quercus macrocarpa, Quercus alba, Carya ovata, Populus tremuloides, Populus grandidentata, Prunus serotina, Crategus* (sp.), and *Pyrus coronaria. Quercus alba, Carya ovata,* and *Pyrus coronaria* were the most abundant trees.

In comparing the two islands it is to be noted that the more severe cutting and the slightly higher elevation of the land in N. T. 1, 8 has evidently been the cause of the development of a more xerophytic vegetation than that found in N. T. 1, 23 and 26. Severe cutting would mean a very marked retrogression in the development of the forest succession, which is best illustrated in the appearance of xerophytic shrubs as the pioneer vegetation. Higher

elevation would mean better drainage, and hence a progression in the forest association which would evolve. Contrasting the few large trees of *Ulmus americana, Tilia americana,* and *Quercus ellipsoidalis,* which were on a slightly lower part of land adjacent to the island in N. T. 1, 8, with the upland hydrarch mesophytic trees which were dominant on the island, these conclusions regarding the retrogression of the forest by cutting and the progression of associations by drainage seem justified.

The small bit of hydrarch mesophytic woods in N. T. 1, 29 is of special interest, first, because it is the only place in the newly acquired forest preserve in which the native shrubs and herbs have been allowed to grow practically unmolested, and thus where the forest is replacing itself; second, because its tree population represents well the transition from the lower hydrarch mesophytic forest type to the higher upland hydrarch mesophytic type of forest. All of the trees and practically all of the shrubs enumerated under the typical hydrarch mesophytic forest were present here. This forest differed from the typical hydrarch mesophytic forest in having *Quercus rubra* and *Quercus alba* as the dominant tree species. Most of the trees here were quite large. They were the trees remaining after the removal of the larger trees from the virgin forest.

The hydrarch mesophytic forest northwest of Lincoln Avenue in N. T. 7, 9 and 27 presented quite a different aspect. It consisted almost entirely of second growth trees from eight to fourteen inches in diameter. This forest consisted of an almost pure sand of *Quercus ellipsoidalis.*

The study of the lowland forests has indicated quite clearly that the forest type is very closely associated with the moisture content of the soil. It has also illustrated how cutting, grazing and fire have caused retrogression in the development of the forest successions toward the climax mesophytic type; and how drainage may cause the hastening of hydrarch successions towards this mesophytic type of forest succession.

The diagram (see Fig. 5) well illustrates the approximate order in which trees were found in the hydrarch succession of the lowland.

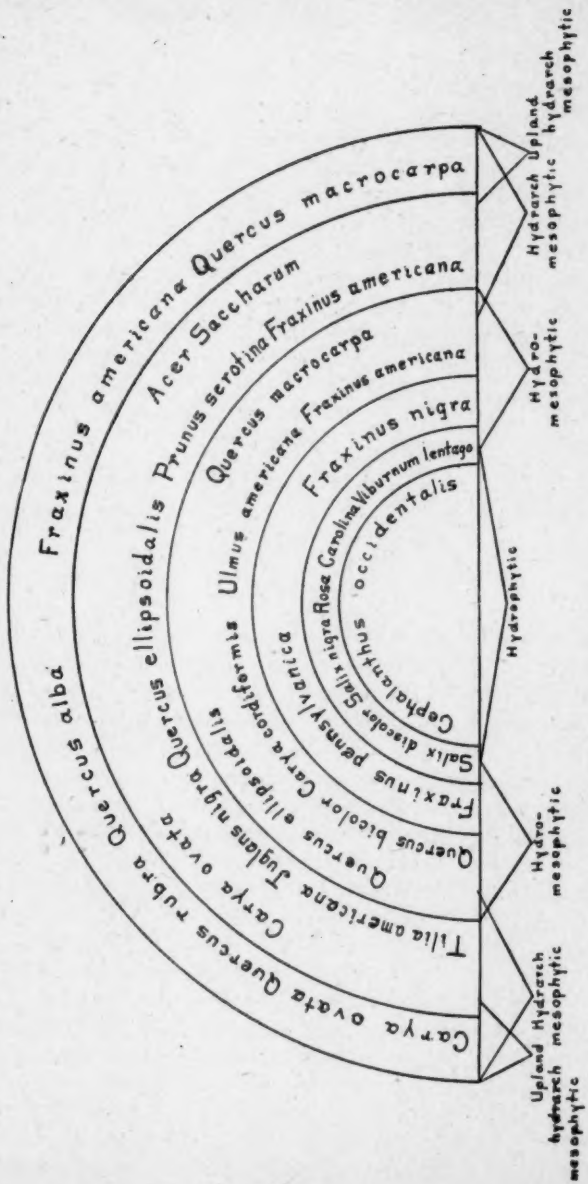

Fraxinus americana
Quercus macrocarpa
Acer Saccharum
Prunus serotina
Fraxinus americana
Quercus macrocarpa
Ulmus americana
Fraxinus americana
Fraxinus nigra
Cephalanthus occidentalis
Salix discolor
Salix nigra
Rosa Carolina
Viburnum lentago
Quercus ellipsoidalis
Quercus alba
Carya ovata
Quercus rubra
Carya ovata
Tilia americana
Juglans nigra
Quercus ellipsoidalis
Quercus bicolor
Carya cordiformis
Fraxinus pennsylvanica
Hydrophytic
Hydro-mesophytic
Hydrarch hydrarch mesophytic
Upland Hydrarch mesophytic
Upland hydrarch mesophytic

Fig. 5

B. The Xerarch Succession.

The upland, the lake bluff and the ravine, which represent the xerarch succession in this region, involve two types of topography—the pre-erosion, comprising the upland, and the erosion, including the lake bluff and the ravine. The xerarch succession exhibited varying types of vegetation from the xerophytic to the mesophytic. A very close relationship was found to exist between the topography, the physical factors, and the vegetation. It was of interest to see how quickly the vegetation responded to modifications of topography or the change in the combination of physical factors. The physical factors which were of greatest importance in either the progression or retrogression of the development of forest associations were light, temperature, soil moisture, wind and waves, gravity and instability of soil. All of these factors were operating in the case of the eroding lake bluff. The angle and direction of slope, in the case of the ravine and the lake bluff, had an important influence upon the type of vegetation represented.

1. The Upland.

The greater part of the entire area studied is composed of the upland mesophytic climax forest. Excluding the ravines and the depressions in the upland, the forest extends from the lake bluff on the east, to the hydrarch mesophytic forest of the Skokie on the west (see map).

The trees most frequently found in this mesophytic forest association were *Quercus alba* and *Quercus rubra*. The former species was the most abundant. The other tree species in this flora were: *Fraxinus americana, Carya ovata, Prunus serotina, Ostrya virginiana, Quercus macrocarpa, Quercus ellipsoidalis, Acer saccharum, Acer rubrum, Tilia americana, Pyrus ioensis, Amelanchier canrubrum, Tilia americana, Pyrus coronaria, Amelanchier canadensis, Crataegus mollis* (?), *Crataegus punctata, Pru-* The shrub species in the order of their importance were *Hamamelis virginiana, Corylus americana, Cornus paniculata, Cornus circinata, Viburnum acerifolium, Viburnum dentatum, Viburnum lentago, Rubus occidentalis, Rubus allegheniensis, Sambucus canadensis,* and *Rosa blanda* (?). *Vitis* (sp.) was also found, but not in great

abundance. *Fraxinus americana* and *Carya ovata* were not as abundant in number of specimens as *Quercus alba* and *Quercus rubra,* but *Fraxinus americana* was abundant, and both *Fraxinus americana* and *Carya ovata were widespread. Acer rubrum* was quite frequent in its occurrence east of the railroad, but was found in only three places west of the railroad. In the former instance it was found usually quite near the lake; in the latter, it was for the most part in places where there was a good supply of soil moisture. It was never found in ravines. *Acer saccharum* was more abundant east of the tracks, and especially in the vicinity of ravines. Whenever it was found in areas where undergrowth was allowed to grow, it was found reproducing itself. *Acer saccharum* and *Tilia americana* were found in similar habitats. The former was the most abundant of these two species in this region.

The present condition of the forest in view of the future, as well as a knowedge of its past condition, is important to note. The upland forest in N. T. 1, A, B, G, H, which includes practically all of the forest area in the new forest preserve, is one of second growth, resulting from the cutting out of large trees from the virgin forest. The trees here are all from seven to fourteen inches in diameter. The entire forest has been so closely pastured that all shrubs and young trees have been destroyed, so that this forest is in a static condition, or is retrogressing, so far as the natural method of its replacement is concerned.

The individual forest areas in N. T. 6, are not very large, but a large percentage of these are reproducing themselves. The majority of the trees were from six to twenty-four inches in diameter. There were practically no areas in which there had been recent cutting. The woods of this entire region, which most nearly approximated the virgin forest, was east of Sheridan Road and north and south of Ravine 4 (Newhall). (See map, N. T. 6, 34, 47, 35, 46, 50). The general aspect of this forest may be seen in Fig. 6. The trees here were the largest in this region, and were reproducing abundantly. Shrubs and herbs were profuse. In forests of this type transpiration and light are reduced to a minimum, moisture is increased, and a mesophytic undergrowth results. *Hamamelis virginiana* was the most abundant shrub growing in

Fig. 6

situations of this nature. It seemed to be a shrub that was confined entirely to mesophytic habitats. Of the trees of the lower stratum *Ostrya virgininana* was the most abundant.

N. T. 7 lies in the more thickly settled and older part of Glencoe. Practically no undergrowth is found in the forests of this area. This means that the vegetation on the whole is in a static condition, so far as reproduction is concerned. With the exception of one area, to be mentioned later, the forests here have all developed within the memory of the oldest inhabitants.

From the number of saplings of *Acer saccharum* which were found in reproducing forests where the maple was found, it seemed reasonable to assume that the maple might soon be counted with oak, ash and hickory in the number and importance of specimens represented in the upland climax forest.

2. The Lake Bluff.

The lake bluff was represented by two topographical types, the relatively stable and the unstable clay bluff. There were all gradations between these types. The stability of the soil depended largely upon the angle of the slope. Where the angle of the slope was greatest, slumping was extreme along the face of the entire slope; where the angle of slope was more gentle, slumping was practically absent. Slumping seemed to be partially due to the formation of water pockets in the soil which resulted either from freezing and thawing of water, or from the decay of vegetation (logs) buried in the soil. The severity of wave action was evidenced by the fact that beaches were either very narrow or totally absent, and by the rows of cobblestones which were left at the base of the bluff as the result of the washing away of the soil from the roots of trees and shrubs.

It was the degree of erosion or slumping which seemed to determine the type of plant associations of the lake bluff. Those plant associations on the less stable part of the bluff had a decidedly xerophytic aspect. These xerophytic associations were gradually replaced by increasingly more mesophytic associations on the more stable parts of the slope. The four plant associations represent-

ing this sequence are (1) the Rhus association, (2) the Populus-shrub association, (3) the Juniperus-shrub association, and (4) the Upland-climax forest association.

a. The Rhus association.—Since the topography and the vegetation are so closely associated it will be well to discuss the topography of the bluff first. With the exception of a very small bit of lake bluff in front of the McLeish property in N. T. 8, S 10, the lake bluff from Park Avenue to a point just south of Dell Place was slumping badly.

The amount, or even the presence of vegetation, depended entirely upon the degree of soil stability. In places there was no vegetation on any part of the bluff; sometimes it was scattered sparsely over its face; then again, it was confined to the upper part of the bluff. Aside from *Rhus glabra* and *Rhus typhina,* which are found in the most xerophytic parts of this association, the vegetation consists primarily of plants from the Populus-shrub and the Juniperus-shrub associations. Among the scattered plants found here in addition to the above were *Ostrya virginiana, Juniperus communis, Salix syrticola, Corylus americana, Cornus paniculata, Populus grandidentata, Populus tremuloides,* and saplings of *Fraxinus americana* and *Tilia americana.*

A picture looking south from a point just north of Ravine 5 (see Fig. 7) shows the steep angle of the actively eroding clay bluff as it appeared eighteen years ago (1900). The photograph taken this year (1918) shows how through continued erosion and the development of a slightly wider beach in places, owing to the building of piers, the angle of slope has been lessened and the vegetation of the Rhus association type has come in (see Fig. 8).

b. The Populus-shrub association.—The Populus-shrub association occurred where the soil of the clay bluff was in a more stable condition than that of the above. This association was best represented from a little over an eighth of a mile north of Ravine 4 (Newhall) (see map, N. T. 6, C 31) to the Cook-Lake County line. An idea of the vegetation and its more or less uniform, though rather sparse distribution over the face of the bluff may be seen in Fig. 9. The trees were small, and the shrubs formed the most conspicuous part of the vegetation.

Fig. 7

Fig. 8

Fig. 9

Fig 10

Fig. 11

The plants taken into account in this association were *Populus grandidentata, Populus tremuloides, Populus deltoides, Populus balsamifera, Ostrya virginiana, Betula alba, Pyrus coronaria, Fraxinus americana, Tilia americana, Prunus serotina, Crataegus mollis* (7), *Juniperus virginiana, Juniperus communis, Rhus typhina, Rhus glabra, Salix glaucophylla, Salix syrticola, Cornus circinata, Cornus stolonifera, Corylus americana, Shepherdia canadensis, Rhus toxicolendron,* and *Celastrus scandens. Populus grandidentata, Populus tremuloides* and *Ostrya virginiana* were the dominant tree species. *Betula alba* was found sparsely scattered over the bluff but was more abundant near the mouth of ravines. *Juniperus virginiana* and *Juniperus communis* were generally found at the base, or extending to the middle of the bluff. Upland types such as *Fraxinus americana* and *Tilia americana* were very rare, but representatives occurred as saplings, and were mostly found only from the middle to the top of the bluff.

c. The Juniperus-shrub association.—Fig. 10 shows an area south of Ravine 4 (Newhall) in which evergreens are dominant. (See map, N. T. 6, 48 and 49). *Juniperus virginiana, Juniperus communis* and *Ostrya virginiana* are the most prominent and abundant plant species present. Shrubs are abundant, and practically the same species are found here as in the Populus-shrub association. The list of shrubs includes *Salix syrticola, Salix glaucophylla, Cornus circinata, Cornus paniculata, Cornus alternifolia, Shepherdia canadensis, Rosa blanda, Ribes cynosbati* and *Hamamelis virginiana.*

Except for *Ostrya virginiana,* the trees of the angiosperm group were not abundant. Those that were present were mostly small saplings and were confined chiefly to the upper edge of the bluff where the majority of them seemed to be encroaching from the upland. *Tilia americana, Carpinus caroliniana, Quercus macrocarpa, Quercus alba, Populus grandidentata, Populus tremuloides* and *Fraxinus americana* occurred here. *Hamamelis virginiana* was found only at the upper edge of the bluff. Near the middle of the bluff was one specimen of *Pinus strobus* which was about one foot in diameter and there were a few smaller white pines between the base and the middle of the bluff face. Some of these latter trees are shown in Fig. 11.

It is of more than passing interest to compare at this point the difference in the aspect of the clay bluff in its early stages of stabilization as studied by Dr. Cowles in 1900 (see Fig. 12), and the aspect in 1918 (see Fig. 13), and to note how rapidly the vegetation spreads over the bluff once the slope has become gentle and stabilization of soil has begun by means of vegetation.

d. The upland mesophytic climax association.—There were two places where the upland mesophytic climax forest type was found (see map). One was north of Ravine 4 (Newhall), (see map, N. T. 6, 31 and 14); the other appears just south of Dell Place and continues south along the lake bluff.

The forest to the north might well represent a typical primaeval mesophytic forest. Fig. 14 shows the gentle angle of slope and how complete the stabilization has become, owing to the dense growth of vegetation. Most of the trees were large, i. e., eight to twenty inches in diameter. All the shrub species were very abundant, in fact, they together with the numerous saplings formed an almost impenetrable thicket. The remnants of herbaceous vegetation together with the species represented in the other life forms indicated a high degree of mesophytism. *Quercus rubra, Fraxinus americana* and *Ostrya virginiana* were the dominant species here. Associated with these trees were *Quercus alba, Quercus macrocarpa, Quercus ellipsoidalis, Tilia americana, Populus grandidentata, Populus deltoides, Acer saccharum, Juniperus virginiana,* and one specimen of *Pinus strobus.* Quite large trees of *Juniperus virginiana* formed a border nearly twenty feet wide along the lower edge of the bluff. All of the trees recorded were reproducing abundantly. Even a sapling of *Pinus strobus* was found.

In company with the trees were the following shrubs: *Cornus stolonifera, Cornus circinata, Cornus paniculata, Viburnum dentatum, Viburnum acerifolium, Viburnum lentago, Corylus americana,* and *Rhus typhina.* There was a luxuriant growth of lianas along the base of the bluff. *Lonicera* (sp.), *Vitis* (sp.), and *Celastrus scandens* were the ones recorded.

Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 17

The forest to the south was quite different in aspect from the one to the north. It might more properly be called a transition forest. The vegetation at the base of the slope consisted of species found in the Populus-shrub and the Juniperus-shrub associations. At the center of the bluff these forms overlapped the upland species of trees and shrubs. The trees here were small, and the vegetation was dense. The plant population was comparable to that of any upland forest.

3. The Ravine.

All of the ravines in this region are drained by Lake Michigan. There were no ravines in the initial stages of topographical development in this territory. Of the seven ravines studied only two were in the earlier stages of development. Considered floristically, and taking the entire ravine into account, there is no such thing as an old ravine, for every ravine has its characteristic flora at the mouth, where vegetation may or may not be present, the head, and in the intermediate area. The vegetation found at these places recapitulates the life history of the vegetative cycle of the developing ravine from its earliest stages.

a. Mouth.—The mouths of ravines varied in both topographic and floristic aspect. The mouths of the Ravines 1, 2, 3 and 4 were, on the whole, less affected by erosion than Ravines 5, 6 and 7. This may have been partly due to the fact that the beaches were wider in N. T. 6 at these points, and hence the slope was protected from the destructive effect of the waves. The mouth of Ravine 5 in N. T. 8, 8 is that of a ravine practically in its initial stage. It had an extremely xerophytic aspect. Fig. 15 gives its aspect as studied by Dr. Cowles eighteen years ago when the entire ravine was in the initial stage of its development; Fig. 16 gives the present aspect of the same ravine. Lateral erosion has caused the widening of the ravine, and although still xerophytic in aspect, the planting of black locust has succeeded in partially stabilizing its face. The mouth of Ravine 2 was almost entirely devoid of vegetation. The north-facing slope of this ravine, however, was covered with vegetation.

The vegetation at the mouth of older ravines was uniformly that of the Populus-shrub and Juniperus-shrub type of the lake bluff. Fig. 17 shows this type of ravine mouth. *Juniperus virginiana* and *Juniperus communis* are the most abundant and characteristic species found at the mouth of most ravines. This vegetation, in all the ravines, extended back into the ravine farther on the south-facing slope than on the north-facing slope. The north-facing slope, in every case, was more mesophytic, even to the very edge of the bluff, than the south-facing slope. The south-facing bank in Ravine 6 (McLeish) is recorded as being much steeper than the north facing bank, and as being so seriously affected by wave erosion as to have no vegetation at its base. Wherever erosion, or unstable soil was found, as at the forking of Ravines 4 and 6 in N. T. 6, 47 and N. T. 8, 23, some distance inland, *Juniperus communis* and *Juniperus virginiana* were growing there.

b. Head.—The heads of the ravines had cut back no farther than the upland. In nearly every case the gully stage at the head of the ravine had been disturbed by man. This modification had been carried back some distance into the Ravines 1 and 3 in N. T. 6, D and E, because they were being used as a part of the golf course. The lateral gully, which is roughly V-shaped in cross section, but whose slopes are more or less convex, may well represent the very earliest stage of the ravine at its source in the upland. Farther to the east the ravines began to have a U-shaped appearance. It was noted in Ravine 4 (Newhall) and Ravine 6 (McLeish) that the U-shaped area became quite broad, up to a certain point, and then gradually merged into the deeper V-shaped ravine. The low part of the U-shaped headland resembled the floodplain of a river. This is well shown in Ravine 4 (Newhall), Fig. 18. The stream at this point had not cut very deeply, but the effects of erosion and deposition of material were seen in a slight degree here. This illustrated the manner in which base leveling is accomplished. In the Newhall ravine the south facing slope seemed to have eroded more than the opposite face, and the slope was on the whole a more gentle one. Alternating temperatures may have

Fig. 18

caused the more rapid erosion of that face of the ravine before it was stabilized by vegetation.

The vegetation in this part of the ravine was the same as that of the mesophytic upland climax.

C. Intermediate Region.—As the U-shaped ravine merges into the V-shaped, there is a deepening of the ravine by the gradual deepening of the stream bed and an increase in the degree of the slope. With these changes come a protection of the vegetation from wind, and a decrease in light intensity, both of which result in reduced transpiration, and greater retention of soil moisture. All of these factors were effective in producing a forest which represents the culmination of mesophytism for this entire region.

The chief tree species in this part of any of the ravines were *Acer saccharum, Tilia americana, Quercus rubra, Fraxinus americana, Ostrya virginiana, Juniperus virginiana, Carpinus caroliniana,* and *Amelanchier canadensis.* The first two were the dominant trees. Upland species such as *Quercus alba* and *Carya ovata* are frequently found in the ravine, but they are confined to the upper edge of the deeper ravines. *Carpinus caroliniana* was found in great abundance on the south-facing slope of N. T. 8, 23. *Ostrya virginiana* was the dominant tree of the lower stratum of the forest. The vegetation in all of the ravines was luxuriant. The maples and lindens were reproducing abundantly.

The shrub species were *Hamamelis virginiana, Corylus americana, Viburnum dentatum, Viburnum acerifolium, Viburnum lentago, Cornus circinata,* and *Gaylussacia baccata. Hamamelis virginiana* was the dominant shrub in all of the ravines. *Gaylussacia baccata* was found nowhere except along the upper edge of the north and east slopes of Ravine 4 (Newhall), in N. T. 6, 47, and 50.

The presence and frequency of the herbs *Hepatica acutiloba, Mitella diphylla,* and *Osmorhiza* (sp.) on the east- and north-facing slopes of the ravines was taken as an indication of greater mesophytism on these slopes, than on the south and west facing slopes. Mosses were abundant in the deeper ravines. They were found most

abundantly on the north- and east-facing slopes, but they were also found near the base of the south-facing slopes. Vines were quite numerous and luxuriant near the base of the slopes; particularly in the vicinity of the lake, in the larger ravines. *Vitis* (sp.) and *Celastrus scandens* were the ones most commonly found.

An observation was made in the McLeish, N. T. 8, during January on the moisture content of the soil of east and west-facing slopes of the ravine. The soil on the west-facing slope of the ravine on which the sun was shining seemed relatively dry, while the water was seeping out of soil on the east-facing slope of the ravine. The connection between this and the plants found on the two slopes was of equal interest. There was almost no herbaceous growth on the west-facing slope, while the east-facing slope was thickly covered with moss.

The slanting and overturned trees in the older ravines, as show n in Fig. 18, demonstrated the fact that there is slow erosion and slumping taking place on the ravine slopes. This slumping of the land is probably due to the abundance of seepage water in clay soil.

Small unweathered pieces of rock (Niagara limestone) were found on the slopes along the entire length of Ravine 3.

This study of the ravines has demonstrated how factors of varying intensity, at the eroding areas of ravines—the mouth and head—in the form of wind, waves, light, alternating temperatures, stream erosion, and soil movement due to seepage water, have affected vegetation.

In the intermediate areas of ravines, where erosive factors are practically nil in their effects, it is of interest to note, how the slight modification of light and moisture conditions, brought about by the change in aspect of slope, cause an immediate difference in the composition of the herbaceous vegetation on the opposing slopes.

Summary and Conclusion.

The plant successions of Glencoe are primarily determined by topography, and are distinguished from one another by the presence, absence or combination of certain physical factors. The important factors in determining

the presence or absence of vegetation, and the grouping of plants into associations are soil moisture, most conspicuous in the hydrarch succession, and wind, waves, light, alternating temperatures, and soil moisture accompanied by soil movement in the xerarch succession.

The hydrarch succession is composed of the hydro-mesophytic association and the hydrarch mesophytic association. *Fraxinus nigra, Fraxinus pennsylvanica* and *Quercus bicolor* are the trees defining the hydro-mesophytic forest; *Quercus ellipsoidalis* is the tree determining the hydrarch mesophytic forest. There were many varieties of the latter species in this region.

The xerarch succession has the largest representation of plant associations. Practically every gradation in the development of a xerarch succession in clay soil, from the most xerophytic to the most mesophytic, was found in this region. The former was represented by the Rhus-, the Populus-shrub, and the Juniperus-shrub associations of the lake bluff; the latter by the *Quercus alba, Fraxinus americana, Carya ovata* association of the upland, and the *Acer saccharum-Tilia americana* association of the ravines.

The old ravine, in its representation of vegetation at the mouth, head and intermediate area recapitulates the history of the xerarch succession for this region.

Both hydrarch and xerarch successions are comprised primarily of secondary associations. Where this was true in the upland and lowland areas, it was attributed to the influence of man through cutting, grazing and fires. Natural delay in the development of associations toward the mesophytic climax of the region, as illustrated by the lake bluff, was due to the severity of conditions brought about by a combination of physical factors.

On the whole, shrubs were found to be more widespread in their distribution than trees. *Ostrya virginiana* proved to be an exception to this, in that it was found equally abundant in all associations of the hydrarch and xerarch succession. This may be due to the fact that it is growing on clay soil, and that it is a soil hydrohypte, and either an air mesophyte or an air xerophyte. *Hamamelis virginiana*

was found only in mesophytic habitats. While *Corylus americana* was found growing with *Hamamelis virginiana* in mesophytic associations, in the main, it was found in less mesophytic situations.

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LEGENDS.

Fig. 1. A section of land (640 acres). Numbers indicate 10 acre plots, letters 40 acre plots of land, or "forties."
Fig. 2. Portion of New Trier Township. Numbers in the figure indicate the sections surveyed.
Fig. 3. Hydro-mesophytic association in which *Fraxinus nigra* and *Quercus bicolor* form the innermost tree zone about the pond (N. T. 1, 17). *Cephalanthus occidentalis* is the shrub growing in the water.

Fig. 4. *Quercus ellipsoidalis* var. *coronaria* is the tree in the foreground. *Quercus ellipsoidalis* and some of its varieties, which characterize the hydrarch-mesophytic association, form pure stands in places (N. T. 7, 9).

Fig. 5. Hydrarch succession of associations from the undrained lowland to the upland.

Fig. 6. Reproducing upland mesophytic climax forest north of Ravine 4 (Newhall) in which *Quercus alba* and *Quercus rubra* are the dominant trees. Note the abundance of saplings and shubbery, and also the heavy mulch of leaves in the undergrowth.

Fig. 7. Eroding morainic clay bluff near Ravine 5, as it appeared in 1900, showing a steep angle of slope and absence of vegetation. After Cowles.

Fig. 8. Lake bluff (same as in Fig. 7) in 1918. The more gentle slope shows the effect of erosion between the years 1900 and 1918. The vegetation (mostly planted) is bringing about the stabilization of the lake bluff.

Fig. 9. Populus-shrub association of the lake bluff. Shrubs are dominant and trees are of small size. The vegetation is xerophytic and sparse, but fairly uniformm in its distribution.

Fig. 10. Juniperus-shrub association in which *Juniperus communis*, *Juniperus virginiana* and *Ostrya virginiana* are the dominant species. Additional shrub species are also abundant. The vegetation is more dense than in the Populus-shrub association.

Fig. 11. Young specimens of *Pinus Strobus* in Juniperus-shrub association.

Fig. 12. Lake bluff (as it appeared in 1900) south of Ravine 4 (Newhall) in its early stage of stabilization. After Cowles.

Fig. 13. Lake bluff (same as in Fig. 12) in 1918, showing rapidity of vegetational development after stabilization of the soil has been completed.

Fig. 14. Reproducing upland mesophytic climax forest on the lake bluff north of Ravine 4 (Newhall) the aspect of which approximates that of a virgin forest. Note the size of the dominant trees (*Quercus alba* and *Quercus rubra*), and the dense undergrowth of saplings and shrubs. The angle of slope is less than in other lake bluff associations.

Fig. 15. Mouth of ravine (in 1900) in the initial stage of the ravine. exclusion of vegetation from its faces. After Cowles.

Fig. 16. Mouth of Ravine 5 in 1918 which shows a widening of the mouth due to erosion and partial stabilization of the slope by the planting of grasses and black locust.

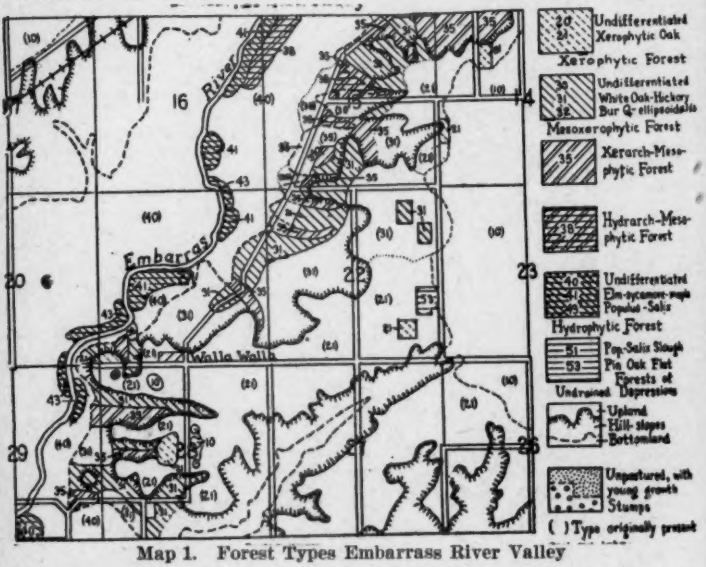
Fig. 17. Mouth of Ravine 3, with Populus-shrub and Juniperus-shrub types of vegetation on its faces. For inland extension of this type of vegetation see Fig. 18.

Fig. 18. Intermediate area (in the foreground) of a mature ravine (Ravine 3) showing the steep north-facing slope (to right) and slanting trees which indicate the beginning of lateral erosion in this mesophytic climax forest. *Acer saccharum*, *Tilia americana* and *Fraxinus americana* are the dominant species. Note junipers in background at mouth of ravine.

PRELIMINARY ACCOUNT OF THE FORESTS IN CUMBERLAND COUNTY, ILLINOIS.

By Arthur G. Vestal, Stanford University, Cal.

Cumberland County is at the northern edge of the lower Illinoisan till-plain. The upland soil is a silt loam, very poorly drained, because of the level surface and the impervious clay subsoil. Practically the whole area is drained by the Embarrass river, which runs south through the eastern part of the county. The valley of the Embarrass is 80 to 100 feet deep and in most places about one and a half miles wide.



Map 1. Forest Types Embarrass River Valley

The Forest Types and Their Distribution.

Table I (see page 215) gives a brief survey of the plant associations and their local distribution. In connection with the table, Map I should be examined. It is sub-

TABLE I. CORRELATION OF TOPOGRAPHY WITH SOIL AND VEGETATION

	TOPOGRAPHY AND POSITION.	SOIL.	VEGETATION.
	FLAT UPLANDS—ABOUT 70% OF AREA.		
1	Broad interfluves away from streams	Gray silt loam on tight clay	Prairie of Lower Illinoisan glaciation.
2	Ends and corners of uplands in spur tops angles between ravines, mostly on leeward side of streams.	Light gray silt loam on clay	Xerophytic Oak Forest, locally advanced to white oak-hickory stage.
3	Poorly drained flats on upland expanses	Silt loam on clay, or clay loam	Pin Oak flats.
4	Slightly raised areas (kames?): infrequent	Yellow-gray silt loam	Elm-hackberry forest.
5	East rim of river valleys	Local deposits of dune sand	Native vegetation not yet found.
	HILL-SLOPES OF RAVINES AND VALLEYS—ABOUT 22%.		
6	Less sheltered slopes, of smaller ravines, and those facing south and southwest.	Yellow-gray silt loam overlying Yellow silt loam	White oak-hickory forest; probably about half of these areas is still in forest.
7	Slopes well protected from sun and wind, mostly of larger ravines, or facing north or northeast.		Xerarch mesophytic forest, with red oak and hard maple; less than half cleared.
		Locally these soils are replaced by sandy loams and sand.	No peculiarities of forest types have yet been correlated with sandy soils.
	BOTTOMLANDS—ABOUT 8%.		
8	Narrow bottoms of young streams	Mixed loam	Mixed mesophytic and hydrophytic forest.
9	Delta-like ravine-mouths in valleys	Brown sandy loam	Hydrarch mesophytic forest.
10	Broader bottoms of larger streams	Silt loams and sandy loams	Mostly ordinary bottomland forest.
11	Stream-sides of creeks	Silt loams, etc.	Black birch, sycamore, willow, etc.
12	River-margins, of recent deposition, etc.	Sand, sandy loam, etc.	Willow-poplar fringe.

NOTE: 1, 2, 4, 5, 9, 10 now mostly under cultivation. 3, 4, 5, 8, 9, 11, 12 of small area.

is submitted as a representative part of the forested valley of the Embarrass river. It is a part of the township in which Greenup is situated, township 9 north, range 9 east. The scale of the map is somewhat more than an inch to the mile. The topography is roughly indicated by the boundary lines separating flat upland, hill-slopes and bottomland. The forested areas are not shown on the west side of the river, nor in the ravines at the southern border of the map. The conventions used to denote the several forest associations are hatched in wherever the forests still stand. The numbers serve to identify them. The type of forest originally present in an area now cleared is indicated by its particular number, enclosed in parentheses. Areas formerly or still covered with prairie vegetation are represented by the number 10. Parts of the extensive prairie uplands are shown at the northwest corner and at the eastern border of the map. The general distribution of forest and prairie is shown for the whole county in Map II, on a succeeding page.

The "ends and corners of uplands in angles between ravines," as mentioned in item 2 of the table, may require brief explanation. These are the flat tops of upland spurs at the valley-border which stand like headlands above the ravines on either side. Their appearance and distribution may be readily seen in Map I, if the reader will follow the line which separates flat uplands from hill-slopes, particularly in section 15. These spur-tops were salients of the prairie areas, closely hemmed in by the forests of the hill-slopes on either side, and in such places the lateral spread of the dry oak forest over the upland surface was initiated. This invasion of forest was slow, and, as shown by Gleason, was subject to frequent check and setback by prairie fires, which were far more prevalent on the windward side of stream-valleys. The summer winds in this part of Illinois are mostly from the south, southwest, and west; and one finds that the upland forest belt is wider, and the spur-tops more generally forested, on the leeward, that is, the north, northeast and east sides of streams. This general relation is quite apparent in the soil maps of Cumberland and other counties in central Illinois. Its result is to make a smoothly curving or nearly straight boundary between prairie and forest, close to the irregular border of the upland on the windward side of the larger valleys, farther from it on the lee side.

The forest types[1] named in the table are not different from the well known forest associations of other parts of Illinois and the adjoining states. Most of them are well known and only two are worthy of special mention at this point. These are pin oak flats and elm-hackberry forest.

1. *Pin oak flats.* The pin oak association is found in small groves, a few acres in area, in extremely shallow depressions of the poorly drained upland. Some of the trees found in it are more abundant in bottomlands, others, as the shingle oak, are frequent in upland xerophytic forest. This vegetation can be correlated with two essential physical conditions, soil which is frequently watersoaked and great exposure of the parts above ground to dryness. The leaves of the two dominant trees, pin oak *(Quercus palustris),* locally known as water oak, and shingle oak *(Quercus imbricaria)* are of xerophytic structure,[2] that is, with thickened cuticle and pronounced development of palisade tissue, the leaf being also thicker. Other trees are swamp white oak *(Quercus bicolor),* green ash *(Fraxinus pennsylvanica,* var. *lanceolata),* honey locust *(Gleditsia triacanthos)* and red maple *(Acer rubrum),* the last forming an understory. Lines of these trees are frequently seen along small streams or ditches, and even along fence-rows in poorly drained areas.

2. *Elm-hackberry forest.* A few examples of small forested areas are still to be found, isolated from the forest system of the valleys, which are dominated by elm *(Ulmus americana)* and hackberry *(Celtis occidentalis).* With these may occur honey locust, black haw *(Viburnum prunifolium)* of small tree size, and in some groves shingle oak.* The seeds of these trees are dispersed readily to considerable distances and it is probable that these forests are of independent and comparatively recent origin in locally favorable spots in the prairie uplands. Those that have been seen are located in areas slightly raised above the general level of the poorly drained upland. Most of these slight elevations are now cultivated. This interesting type of forest requires further study.

[1] For those not familiar with ecological terms, a few used in the table and in the map legend are here described: xerophitic, of dry exposed situations; mesophytic, of intermediate situations, that is, rather sheltered from wind and sun and with a moderate supply of soil moisture; xerarch, developing from xerophytic vegetation or in formerly xerophytic habitats; hydrarch, developing from hydrophytic conditions.

[2] See footnote 5 page 000.

CORRELATION BETWEEN FOREST AND SOIL TYPES.

The field study has been inestimably aided by the State Soil survey map of Cumberland county, of which an advance copy was kindly furnished by Professor J. G. Mosier. One problem has been to find what agreement there may be in local distribution of soil types and forest associations. It was soon determined that the boundaries between areas marked as upland timber soils and those of upland prairie soils, serve equally well as boundaries between prairie and forest vegetation. The light gray silt-loam on tight clay, with xerophytic oak vegetation, differs from the gray silt-loam with prairie vegetation, only in having a slightly lower organic content. This at once suggests that the slight difference in soil may be the result of the difference in vegetation, a hypothesis which is supported by the facts of vegetational history. The writer is rather confident that the original distribution of xerophytic oak forest, now mostly destroyed, corresponds very nearly with that of the light gray silt-loam, as shown conspicuously on the soil map in yellow. Likewise prairie vegetation boundaries have been found to coincide with prairie soil boundaries. The soil map is therefore of very great value to students of vegetation and to foresters.[3]

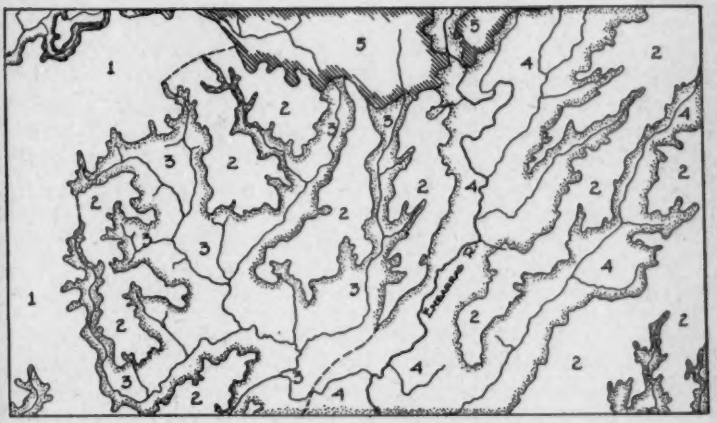
Correspondence between forests and soils on the hill slopes and bottomlands is less detailed and exact than on the uplands, and without causal connection. The soils are in horizontal strata and are successively uncovered by erosion, so that the soil boundaries coincide more or less closely with the contour lines. Thus soil distribution is controlled by topography. Vegetation distribution is also controlled by topography but in somewhat different ways. Thus, in ravines, a south-facing slope is commonly covered with oak-hickory forest, while the north-facing slope has a mesophytic forest, with red oak, maple, etc. But the soil types of the two slopes are the same and, on both slopes, the same forest type extends over two or three soil types. A re-examination of Table I will show the kinds of soils associated with particular kinds of forests and may perhaps also show that vegetation is more closely dependent upon topography and aspect than upon soil. To sum-

[3] It might be expected that the vegetation served somewhat as a guide in the field study for the soil survey, and this is suggested by their classification of soils into upland timber soils and prairie soils.

marize, general correspondence between soil types and forest types is to be made out, more in detail upon the upland, but soil types and vegetation types are both more closely dependent upon topography than upon each other.

Geographic Subdivisions of the Area

The area of Cumberland county is only 350 square miles. but in it can be distinguished five geographic subdivisions. They are shown in Map II, which was made from the soil survey map as a base. The subdivisions are as follows:



Map 2. Geographic Subdivisions of Cumberland County. For description see text.

1. Upland prairie of the western border of the county.
2. Inter-stream upland prairies.
3. Forest area of the western creeks.
4. Forest area of the Embarrass and the eastern creeks.
5. Morainal outwash plains of the northern border.

These will be taken up in order.

1. The upland prairie of the western border is considered as slightly different from the inter-stream areas because of differences in floristic composition and in vegetational history. Being so much more extensive than the inter-stream prairies, it has been less encroached upon in the slow spread of forests from the valleys. In parts of the western upland border which are distant from the forest

areas by as much as one to several miles, the undrained flats are likely to be characterized by scattering cottonwoods and occasional elms, rather than by the pin oak association.

2. In using the plural form of the noun prairie for upland inter-stream areas, the writer follows local custom. The term prairie is used by the residents in a physiographic rather than a vegetational sense. A prairie is a flat treeless expanse to them, rather than a particular kind of grassland vegetation, and it matters not whether native vegetation remains. Some of these prairies are known locally by individual names.

3 and 4. The forest area of the western creeks lacks certain tree species of the Embarrass valley and those of eastern creeks, and includes a somewhat higher proportion of xerophytic oak forest. A somewhat peculiar forest association is found along the upper stretches of those creeks which head in the upland prairie, especially that of the western border; this forest type is made up of pin oak and shingle oak, with hickory, post oak and other xerophytic trees in admixture.

5. The outwash plains on the lower side of the Wisconsin moraine, in the northern part of the county, were generally covered by a mixed forest, still preserved in many small areas, in which elm is the most abundant species. Other trees are shagbark hickory *(Carya ovata)*, white oak *(Quercus alba)*, shingle oak *(Quercus imbricaria)*, black walnut *(Juglans nigra)*, and white ash *(Fraxinus americana)*. The northern part of this outwash surface is better drained than the southern fringe, which merges into the prairie uplands of the older glaciation. It would appear from such field studies as have been made that there is consequently a transition in floristic (and ecologic) character of the forests of the moraine from its higher parts southward to the base of its outwash; on the higher parts the white oak-hickory forest is typically developed; on the outwash slope white oaks become fewer toward the south, and elm, shingle oak, ash and honey locust *(Gleditsia triacanthos)* become progressively more numerous. This transition requires additional study.

Floristic Geography.

Floristic aspects of plant geography emphasize the peculiarities of distribution of particular species of plants. Certain other interesting floristic features are presented in Cumberland county.

A north-south floristic transition results from the fact that migration of trees has proceeded upstream along the valleys of the generally southward-flowing streams, and that certain tree species are here nearly at the upper limit of their distribution along the Embarrass drainage system. The sweet gum *(Liquidambar styraciflua)* formerly grew on the Embarrass near the southern edge of the county. The writer knows of no more northerly station for it in Illinois. The mulberry *(Morus rubra)*, *sassafras (Sassafras sassafras)*, *persimmon (Diospyros virginiana)*, coffee tree *(Gymnocladus dioica)*, dogwood *(Cornus florida)*, and papaw *(Asimina triloba)*, though all range considerably to the north, are increasingly abundant and grow to larger size southward.

Pin oak *(Quercus palustris)*, post oak (Quercus minor), and the river birch *(Betula nigra)* are common in Cumberland county, but only post oak is known by the writer to occur in Coles county, just to the north, and that very rarely. The black-jack oak *(Q. marilandica)* occurs rather infrequently in Cumberland county though it is common fifty miles south in clay soil, and is abundant in the sandy parts of the Illinois river valley. Probably the absence of the three oaks mentioned from the area just north of Cumberland county is due to the difference in soils upon the two sides of the moraine, not that these species could not grow in the better soil on the northern side, but they probably can not compete successfully with the other trees which grow there. The difference in soil is well indicated by the presence, in the lower Illinois glaciation, of the two herbs, *Ambrosia bidentata* and *Plantago aristata*, which appear most commonly as roadside weeds, though originally they were probably members of primitive (pioneer) prairie associations.

An east-west floristic transition results from the westward migration of trees, as the forest encroached upon the prairie region. Certain tree species are well established along the valleys all over Illinois, but certain others, as

the beech *(Fagus grandifolia)* and the black gum *(Nyssa sylvatica)* are confined to the eastern border of the state. Their migration farther to the west, as well as that of many herbaceous forest species, must be greatly hampered by the generally north-south direction of the drainage lines. The east-west transition is therefore more rapid than the north-south transition. The resultant of the two transitions is a direction from about north-northeast to south-southwest for the boundaries of the range of certain species, as the beech, and for the general tension line between forest and prairie in eastern Illinois and western Indiana.

Thus, of the western tributaries of the Wabash river crossed in a given latitude, those farther to the east would show the richest forest flora. The valleys of the eastern creeks of the Embarras itself have several trees not present, so far as the writer has been able to find, in the area of the western creeks, except near their junction with the Embarrass. Among these are the Kentucky coffee-tree *(Gymnocladus dioica)*, the big shell-bark hickory *(Carya laciniosa)* and river birch *(Betula nigra)*.

Vegetational Changes.

The views of Gleason[4] as to the development of vegetation in the middle west indicate the probable existence of several historic periods after a prairie-like vegetation had established itself upon the upland: (1) a period of forest advance up and from the valleys; (2) a period of prairie fires in which the prairie vegetation increased its area, except where sloughs or streams protected the forests from fire; and (3) the present period in which fires are prevented, but forest spread has been checked by cultivation. The xerophytic oak forests of the Cumberland county region are plainly in situations which are protected from fire. This may be either because the forests have been preserved in such areas, or because the absence of fires has enabled forests to develop recently, during or since the period of fires. Probably both types of xerophytic oak forests are present—the survivals of prairie fires and those which have developed more recently in protected situations.

[4] Ann. Ass. Am. Geog. 5:135-136, 1915; Bot. Gaz. 53:38-49, 1912.

The presence of the pin oak flats scattered about on the interstream prairie uplands presents an interesting problem. If these small pin oak groves are of recent origin, then the pin oaks and shingle oaks must be more mobile than has been realized. If they are not more mobile than other oaks, then it is probable that these pin oak groves are relics, in the wetter situations, of forest areas elsewhere replaced by prairie as a consequence of fire. Evidence for both sides of this question is at hand. These two oaks come up freely along fence-rows and ditches along with plainly mobile species, such as elm and choke-cherry. Probably they are more mobile than oaks with larger acorns and may easily be carried by certain birds. Probably, also, they may be mobile only for relatively short distances, for hardly a spot in the inter-stream uplands is more than a mile or half-mile from a grove or line of trees or from the forest system of the valleys. The absence of pin oaks and the presence of cottonwoods on at least part of the more extensive prairie upland of the western border bears out the notion of their limited mobility[5] and indicates a difference from the smaller inter-stream uplands. Possibly the inter-stream uplands may once have been generally forested, while the western border remained treeless and fire-swept. If this is true, then a careful comparison of the remaining prairie floras of the two areas may reveal herbaceous relics of forest over the inter-stream uplands. Such forest herbs do persist among the prairie herbs in parts of Coles county, just to the north.

Furthermore, evidence is common both that forest has succeeded prairie and that prairie has replaced forest within even the last sixty years. If such radical changes can take place within so short a time, it need not surprise one that inference should call for perhaps a succession of fluctuations between prairie and forest.

[5] Since this was written, further evidence appears in the discovery of a single young plant of shingle oak in an elm-hackberry grove. Obviously the shingle oak did not get in until the more mobile trees were established. This grove, which is six miles northwest of Charleston, is small and probably of recent origin. It is about two miles distant from the nearest tongue of ordinary forest, which follows a small stream. Another isolated elm-hackberry forest known as Round Grove, two or three miles east of the northeast corner of Cumberland county, is larger and older and contains a considerable number of fair sized shingle oaks, which, however, seem to be younger than the large elms and hackberries. There are other groves with no oaks at all. Shingle oak thus seems to be much less mobile than elms and hackberries, and much more mobile than other oaks and hickories. Pin oak is usually found with shingle oak in the inter-stream uplands of Cumberland county, and is probably of the same order of mobility.

The detailed sequence of events in any particular station has been largely controlled by topography and by geographic position with respect to streams and slopes, which is a matter of topography. This explains the emphasis laid upon topography as the controlling factor in local distribution of vegetation, in an earlier passage of this paper.

Changes Brought by Settlement.

Even as recently as sixty years ago, Cumberland county was a very different kind of country. Much of the prairie area was covered in spring and early summer by extensive sloughs, abounding with ducks and other water and shore birds. Their deeper parts persisted as permanent ponds. These sloughs are now almost gone, though tile drainage has not been put in extensively. Practically all of the prairie upland is now under cultivation, though much of it is comparatively unproductive. The proportion of area devoted to pasture and meadow is much higher than in the black land of the Wisconsin glaciation to the north. Roads are numerous but unimproved. Trees are planted about farm-houses, hedges are common and the more mobile trees are springing up along roads, fences, and ditches.

The forested area is thinly settled except for the fertile bottoms of the larger streams, now almost entirely cultivated. Most of the xerophytic oak forest of the flat uplands has been removed. The hill slopes are largely kept in timber, though all of the original large trees have been cut. Small sawmills are rather frequent, but are seldom in steady use. Pasturing of forested areas is general and in places destructive erosion has resulted. There are only a few wagon bridges across the Embarrass, which is subject to flood, and foot bridges of the suspension type, built of wire fence, are occasionally found.

Influence of the Shelbyville Moraine.

The country to the north, with its newer soils of the Wisconsin glaciation, is different in many ways, physiographic, vegetational and cultural. A few of the differences have been hinted at in various places but a fairly adequate treatment of the subject would require many pages and will not be attempted here. It is here suggested

merely that the fact that there are differences should be kept in mind, and that future studies of Cumberland county forests should include a comparison with those of the forests in the richer land of the later glaciation.

ON THE FORESTS OF LA SALLE COUNTY, ILLINOIS.

GEO. D. FULLER AND P. D. STRAUSBAUGH, UNIVERSITY OF CHICAGO.

The forests of La Salle County are of particular interest not so much on account of their economic value as because of their intimate relation to soil diversity and stream development. The soils have been carefully surveyed, classified and mapped by Hopkins and Mosier[1] and it is largely upon their admirable reports and soil maps that the present forest survey is based.

SOIL CONDITIONS.

The diversity of soil is due to the situation of the county in the north-central part of the area included in the early Wisconsin glaciation. Five distinct classes are recognized, as follows:

1. Upland prairie soil with gently rolling surface, the relief often being too slight for good natural drainage.—To the depth of 3 to 5 feet this soil consists of loam formed principally from wind blown material. With this is mingled more or less silt and an average of 6 per cent of organic matter resulting from the decay of the roots and stems of the grasses which have been the principal vegetation. The soil varies in color from brown to black and covers about 82 per cent of the 1157 square miles which are contained within the limits of the county. The subsoil is usually a yellow clayey silt, in places mingled with glacial drift. A prairie vegetation of grasses and herbaceous plants seems to have been the original cover of this soil, at least within all the areas included in this report, but at present cultivated grains and grasses have very completely replaced the plants of the original prairie turf.

[1] Hopkins, Cyril G., Mosier, J. G. et al. La Salle County soils. Univ. Ill. Agri. Exper. Station. Soil Report No. 5: pp. 45 pls. 5. maps 4. 1913.

2. Upland timber soils usually found along the stream courses and covering about 12 per cent of the surface of the county.—These are silt loams varying in color from yellow to grey and containing about 3 per cent of organic matter resulting from the decay of former vegetation. Differing from the prairie soils in color, in low organic content, and in the possession of a more rolling surface, they present a still more striking contrast in the character of their native vegetation which was almost exclusively a forest in which oaks were conspicuous. They usually possess as subsoil a plastic yellow clayey silt, often mingled with glacial drift forming a gravelly clay frequently lacking in permeability. These soils are usually less fertile than those of the prairie type and offer more difficult problems of cultivation and fertilization.

3. Terrace soils deposited by stream action in the valleys of the larger rivers.—These are usually to be referred to the action of over-loaded streams, during the melting of the glaciers, partly filling the valleys. Later the streams cut through this material and developed new flood plains at a lower level. These soils vary from such silts as are seen in the valleys of the Vermilion and Illinois Rivers to the sands and gravels occurring in the valley of the Fox River, but in general they consist of brown or grey silt loams with varying amounts of sand and organic matter. They occur, as their designation indicates, in the form of benches or terraces along the larger streams, covering about 3 per cent of the surface of the county, and are usually fertile and well drained.

4. Swamp and bottom-land soil mostly of a recent development upon the wide level flood plains of the Illinois River.—As a rule this type of soil is poorly drained, often submerged during periods of high water, and consists of brown silt loam containing about 4 per cent of organic matter. It is however most fertile, producing heavy crops wherever the drainage permits. Very little more than 2 per cent of the county is covered with soil of this type. Here may be included small areas of peat less than one square mile in extent.

5. Residual soils formed by the accumulation of loose material from the weathering of rocks in place.—While such soils cover less than 3 square miles, La Salle County

has probably the largest area of tillable residual soil to be found in Illinois. These soils come from the disintegration of shale and sandstone and vary from sandy loam to sand. Their small area is due not only to the wide extent of the ice sheet and to its action in removing disintegrated rock or in covering it with glacial drift or boulder clay, but also in the southern part of the state to the large deposits of wind borne loess burying the products of rock decay.

Stream Development.

The water courses of the county differ greatly in age and present many stages of development from small intermittent streams, just beginning to entrench their channels in the prairie soil, to great rivers flowing in broad valleys deeply cut in soil and rock even before the coming of the ice sheets. The forest distribution is so closely associated with the diversities of stream development that it seems advisable for our purposes to recognize four distinct stages of erosional development.

1. Small streams, often intermittent.—These are shallowly entrenched in the comparatively level surface of the prairie and have done little or no cutting except to excavate the channels through which their waters flow. All the streams of Meriden and Mendota townships belong to this class.

2. Creeks with shallow valleys.—These have cut through and removed portions of the prairie soil exposing strips of the underlying subsoil which become the "upland timber soils." In these subsoils their channels are entrenched but their valleys show little lateral cutting and almost no deposition. The Little Vermilion furnishes a typical example of a stream of this class. It may be noted that the soil maps show many streams of this class with a border of timber soil, or in other words a valley slope, distinctly broader upon its left or eastern bank. The cause of this unequal cutting and its significance in forest development will be reserved for discussion in subsequent paragraphs.

3. Small rivers.—To this class are to be referred streams that have cut through the soil mantle almost or quite to the underlying rock and are now doing comparatively little vertical erosion. They are engaged in widen-

ing their valleys, in cutting terraces and occasionally in building up flood plains. Here belong the lower stretches of Big Indian Creek and the part of Fox River within La Salle County.

4. Large rivers.—These are comparatively mature streams showing broad deeply cut valleys and a considerable expanse of flood plain. In this part of the State they must antedate the ice sheets and show evidence of more active cutting due to greater volume of water. Only the Illinois River has reached sufficient maturity to be referred to this class.

No forests whatever are associated with streams of the first class except an occasional fringe of willows not more than a few yards wide or occasionally isolated trees of river maple or cottonwood. Upon the gentle slopes of the stream valleys of the second and third classes are developed the upland forests while bottom and swamp forests are almost exclusively confined to the river bottoms associated with streams of the third and fourth classes. This report has to do principally with forests associated with streams of the second class and is limited to 12 townships in the northeast portion of the county. Within these townships there are found some 5684 acres that possess a sufficiently dense population of trees to be classed as woodlands and forests. Almost the entire area is in pasture and some would probably be more accurately described as wooded pasture rather than forest so scattering is the stand of trees and so completely absent are all forest shrubs and flowers. So intensive has been the grazing that only in isolated small patches is there any reproduction in progress and the size of the standing timber would indicate that these conditions have not varied greatly during the past 25 years at least, for few trees of 3 inches in diameter or less are to be found. On the other hand almost all tracts show cutting, very few trees remaining that are over 20 inches in diameter. This shows that the more valuable mature timber has been removed and according to the testimony of various people resident in the vicinity much of this cutting was done 20 to 40 years ago. Only occasionally is there any evidence that tracts have been cut off clean and subsequently reforested.

General Recommendations.

The preservation of the natural forest vegetation over certain limited areas to serve as public parks is important and has received some of the attention it so greatly deserves. Private owners have done their part as well as the state. Instances of the public spirit and generosity of individual citizens are seen in the pleasure grounds of Deer Park and Matthison Park just outside the limits of the city of La Salle, both due to the generosity of the late Mr. Matthison. While his heirs are still extending the use of these beautiful spots to the public and also providing for their upkeep, their permanency should be insured by vesting their control in the state, the county or the city. The former area might well become an extension of the present Starved Rock State Park, while the latter from its size and situation would naturally become a public park for the city of La Salle.

The State has shown its appreciation of the importance of such forest reservation by the inclusion of a most beautiful and well wooded portion of the Illinois River valley in the Starved Rock State Park.

A smaller but equally commendable enterprise was the establishment of the Shabona State Park upon the site of an Indian massacre in 1832. This forms an excellent precedent for the commemoration of other events of historic interest by the preservation of larger or smaller areas of forested land as state or county parks.

Classification of Forests.

Forests may be grouped into classes depending upon the similarity of the situations in which they occur and of the species of which they are composed. The forester speaks of these classes as "forest types," while the ecologist more usually refers to them as "forest associations" and the meaning of the terms is so similar that for our purpose they may be considered as identical and preference may be given to the forester's terminology. In a former report on the forests of the state, Hall[1] has distinguished two classes of forest types, those of the upland

[1] Hall, R. Clifford and Ingall, O. D. Forest conditions in Illinois. Ill State Lab. of Nat. Hist. 9: 175-253. pls. 21-36. 1911.

and those of the bottom-land areas. While his report refers principally to the forests of the southern part of the State, his classification of forest types may in general be followed.

It is recognized that any classification whatever of forests into a system of types or classes presents several difficulties, not the least of which is the fact that such types gradually merge into one another by gradations that are often almost imperceptible. Still classes are necessary for the mapping and intelligent discussion of any considerable area of woodland. The following subdivisions are offered as a provisional scheme arranged upon the principle that it is best to have a small number of classes based upon broad resemblances and differences. Variations in these types, when of sufficient importance or when they involve sufficiently large areas, may be noted in the discussions of the distribution of forests in the individual townships. The application of the proposed classification is at present to be limited to the requirements of a portion of La Salle County, although it is confidently expected that with slight modifications it will be equally serviceable for any portion of the State.

I. Upland Types.

These types include both the forests of hills and upland plains although only the latter will be found within the limits of La Salle County. Throughout the State various species of oak dominate the uplands, the species differing upon different soils and in different localities. Usually the soil of any particular type differs from neighboring forested or non-forested areas. Two main types may be distinguished:

1. *Upland oak forest.*—The type of forest most extensively developed in La Salle and also in many neighboring counties is upon the uplands (mostly upon soil 1134 of the Soil Report) and consists largely of various oaks, with some admixture of hickory, so that it is often and quite appropriately spoken of as the "oak-hickory forest." In anything like its original conditions it is a rich forest in which either white *(Quercus alba)* or red oak *(Q. rubra)* form from 50 to 80 per cent of the stands with varying admixtures of bur oak *(Q. macrocarpa)*, shag-bark hick-

ory *(Carya ovata)*, elm *(Ulmus americana)* and sugar maple *(Acer saccharum)*. A few other trees such as black and scarlet oaks and black cherry *(Prunus serotina)* are sometimes present in smaller numbers. When not too heavily grazed the undergrowth consists of seedlings of the principal trees, showing that the forest is a permanent one, and of a variety of shrubs among which the panicled dogwood *(Cornus paniculata)* and the hazel nut *(Corylus americana)* are the most universally present. The herbaceous undergrowth is rather varied and rich. A more detailed description of the characteristics and composition of a forest of this type will be found upon a later page of this report.

2. *Dry oak forest.*—This is usually developed upon areas that are rather deficient in soil moisture, either from their elevation above the surrounding country or because of the poor water holding capacity of the soil due principally to a deficiency of organic matter in the form of humus. A typical forest of this type usually contains a large quantity of black oak *(Q. velutina)* the amount varying from 50 to 90 per cent of the stand. White and bur oaks of small size and in small numbers are commonly present. The New Jersey tea *(Ceanothus americanus)*, the false indigo *(Amorpha fruticosa)* and the maple leaved haw *(Viburnum acerifolium)* are commonly the characteristic shrubs, while among the herbs are sunflowers, blazing star, prairie clover and golden rod together with such prairie forms as the prairie dock *(Silphium terebinthinaceum)* and the rattle snake weed *(Eryngium yuccaefolium)*.

II. Bottom Land Types.

These are confined to the river valleys and are developed both upon alluvial and other soils. They, too, may be divided into two types whose development is dependent principally upon the condition of the drainage.

1. *Rich bottom forest.*—This type is confined to the lower terraces and well drained flood plains along streams. Its typical trees are walnut *(Juglans nigra)*, white, black and green ash *(Fraxinus americana, F. nigra* and *F. pennsylvanica)*, Elm *(Ulmus americana)*, basswood *(Tilia americana)*, bitternut hickory *(Carya cordi-*

formis), bur oak *(Quercus macrocarpa)* and occasionally a small proportion of hackberry *(Celtis occidentalis),* buckeye *(Aesculus glabra)* and mulberry *(Morus rubra).* Small trees of hawthorn or thorn apple and wild crab are usually present and if not too heavily grazed such shrubs as gooseberry, elder, bladder nut, wahoo and prickly ash are to be seen. In very few places within the limits of the townships included in this report are the characteristic herbaceous plants present since owing to the open stand and the heavy grazing they have been replaced by pasture grasses and herbs.

2. *Stream side forest.*—Confined to the stream borders and lower flood plains there is usually a collection of such trees as the river willow *(Salix nigra),* river maple *(Acer saccharinum),* cottonwood *(Populus deltoides)* with smaller willows and button bush *(Cephalanthus occidentalis)* as undergrowth. This type is commonly confined to a strip of no very great width along the stream margin or to the site of former ox-bow lakes. It usually passes rather quickly but with no very sharp line of demarcation to the rich bottom forest previously described. The distinction usually made between the two types is that stands composed principally of willow and river maple are regarded as belonging to the stream-border while walnut, ash and basswood may be regarded as indicative of the bottom forests. In the southern part of the state many different trees appear in these and in the bottom land forests.

Distribution of Forests.

As the relationship between soil and forest distribution is nowhere more clearly manifest than in La Salle County it has seemed fitting that this report should follow a similar order to that employed in the field survey, that is, the tracts of prairie soils were examined first and then those areas in which soils of other types were found were investigated. Such a program pointed to the northwest corner of the county as the most natural starting point. The maps accompanying the report are arranged in the same order, similar and adjacent townships being grouped. It may be noted here that tree planting about homesteads of a half acre or less is not regarded in deter-

mining the forested area. Generally these trees are limited to a single row and are often imported species such as Norway spruce and Lombardy poplar.

In general the strip of forest fringing the streams having a north and south course is decidedly more extensive upon the east than upon the west side. The explanation commonly current for this inequality of distribution is connected with the theory that the prairies are caused by the prevalence of fires which destroy the trees. Streams naturally act as barriers to the advance of prairie fires, this advance usually being in the direction of the prevailing wind from west to east. This would lead to a greater destruction of forest trees upon the west bank of north and south streams. This explanation might have been accepted as a probable one had not the soil maps shown the close coincidence of the distribution of the yellow-grey silt loam (1134) and that of the upland oak forest. And since an examination of the soil maps reveals the fact that the expanse of the yellow-grey silt loam (1134) fringing the Little Vermilion, Big Indian Creek, Little Indian Creek and other streams is decidedly greater on the east than upon the west bank we are led to conclude that, in this county at least, soil distribution and not fire is the controlling factor of forest distribution. Upon a subsequent page an attempt will be made to explain the irregular distribution of the soil in question.

Mendota Township (Map 1).

An examination of the maps of the soil reports already mentioned shows that the entire surface of this township is covered with prairie soils. Over 95 per cent of the area is the brown silt loam (1126), the remainder being black silt loam (1125). The altitude of the northern portion of the township is slightly over 900 feet, sloping gently to 720 feet at the southeast. The surface is very gently rolling and several branches of the Little Vermilion have slightly entrenched themselves (Map I), forming channels that are without water during part of the summer. Only along these streams is there the slightest indication of any natural tree growth and this consists of a very scanty and much interrupted fringe of black willow which in one locality only is more than a single row of trees, in-

terrupted by wide intervals. Bureau Creek barely touches the northwest corner of the township and a small amount of the woodland associated with its course extends into Section 6. This forest has quite disappeared. About a reservoir in Section 29 (Map I, a) the black willows have covered perhaps one acre while adjoining the willows in Section 28 is a plantation of less than a half acre of black walnut from 2 to 4 inches in diameter. Two or three patches of silver maple *(Acer saccharinum)* in Sections 32 and 20, evidently planted, although now making a close stand of trees from 8 to 20 inches in diameter and a patch of young Catalpas 2 to 8 inches in diameter in Section 20 (Map I, b), make the total forested area of the township not more than three or four acres, two-thirds of which is undoubtedly due to planting. What is quite as important is the fact that there is no evidence that the original forested area was more extensive. It seems certain that a landscape of uninterrupted prairie greeted the eyes of the first settlers. There is scarcely an acre of waste land in the township and cultivation has been so thorough that even roadsides and the railroad right-of-way show very few remnants of the original prairie vegetation. Such remnants are marked by the presence of prairie docks, compass plants, golden rods and sunflowers.

Meriden Township (Map I).

Meriden lying immediately east of Mendota resembles it in being essentially a forestless area. Sloping gently from the north its surface is covered with prairie soils, among which the brown silt loam (1126) is most widely spread covering over 90 per cent of the surface, with a few hundred acres of black silt loam (1125) and one small area of black clay loam (1120). All these upland prairie soils are again found to be treeless except for the narrow and much interrupted willow fringe along some streams. These streams are almost all tributaries of Big Indian Creek, the largest being known as Four Mile Creek. None of them are deeply entrenched nor have they developed sloping valleys except at the northwest corner of the township where Four Mile Creek has cut somewhat more deeply on account of the local elevation, due to the presence of the Bloomington moraine (Map I). Here there are about 150 acres of upland timber soil (1134) bordering the stream

and this was evidently originally entirely covered with trees now largely cut away or thinned out. The forest is of the upland oak type, with a small admixture of bottom forest trees near the stream. At the southern extremity of the area a stand of about 10 acres of mixed oak and elm has been so little culled that it covers the ground rather closely. North of it comes an open space and areas of pasture with scattered trees. In all there are about 75 acres upon which trees are sufficiently numerous to be classed as forest. Here, as elsewhere, as the trees become more and more scattering it is difficult to say whether portions of a pasture are to be classed as forest or not. All parts of this area are grazed and many possess only a very open stand of trees that have usually a trunk diameter of 6 to 20 inches.

Ophir Township (Map II).

This is another prairie township with small streams, often drying up in summer, flowingin shallow channels with their valleys quite undeveloped. These are mostly tributaries of Tomahawk and Vermilion Creeks and only with the latter is there any forest development associated. The upland prairie soils are uninterrupted, except in Sections 18, 19 and 30, the brown silt loam (1126) as before covering over 90 per cent of the area. In Sections 18, 19 and 30 the action of the branches of the Vermilion Creek have evidently removed the surface prairie soil and exposed 800 acres of the underlying yellow-grey silt loam (1134) which is one of the upland timber soils.

Originally the extent of the forests seems to have coincided with the distribution of this timber soil, but now nearly three-fourths of the area has been cleared, some so recently that the stumps remain in the pastures.

The forest soils in Section 30 and in the south half of Section 19 are entirely cleared although over a hundred acres of stump pasture testify to their former cover of the upland oak forest type. In the north half of Section 19 and the adjacent portion of Section 18 about 200 acres of upland oak of fairly good quality still remained at the time of our visit (September, 1918), although cutting was then in progress.

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Waltham Township (Map II).

The surface of this township is composed almost exclusively of soils of the prairie type, the one exception being in the southwest corner where in Sections 29, 30, 31 and 32 some 680 acres of upland timber soil are associated with Pecumsougan Creek. Only a small portion, estimated at 20 acres, now remains in forest. This estimate is made on quite insufficient data and the area must be visited again before making a final report.

Wallace Township (Map III).

Wallace township includes the 27 western sections of Township 34 North, Range 3 East, and with the exception of some 50 acres in Section 35 is entirely covered with prairie soils. Less than half of this potential forest area is now covered with an open mixed forest.

Troy Grove Township (Map II).

The western half of this township is similar in its surface characteristics to those already discussed, being slightly rolling, entirely covered with upland prairie soils with brown silt loam constituting over 90 per cent of the surface, and with the various branches of Spring Creek slightly entrenched providing for its drainage by their intermittent flow. It is quite without native forest covering and an acre of white poplar and cottonwood in Section 7 (Map II, a) seems about the only attempt at planting more than a row of trees.

Through the eastern half of its area Vermilion Creek has developed its valley in an expanse of upland timber soil including all of Section 24, most of Sections 13, 25 and 35, the west half of Section 14 and smaller portions of Sections 10 and 11. This timber soil is almost exclusively of the yellow-grey silt loam type (1134) with a narrow fringe of yellow silt loam immediately bordering the stream. Its extent is slightly more than 2500 acres and there is good evidence that it all was originally forested. Four-fifths have been cleared and are now being cultivated leaving about 500 acres still in forest. Much of this is very open, constituting little more than a fringe along the stream or a covering of the steeper slopes of its valley.

Only 20 or 30 acres in Section 14 are sufficiently free from grazing to permit any reproduction. While it is evident that there was formerly some selective cutting of the better timber from this area it has been little disturbed for many years as shown by its trees ranging from seedlings to those 24 or even 30 inches in diameter. Oaks constitute 80 per cent of the stand, the red, white and bur oak being abundant with an occasional black oak. Next in importance are shagbark hickory and elm with occasional black cherrry, sugar maple and hop hornbeam. It is believed that this area represents very closely the character of the original stand over three-fourths of the wooded area of this and neighboring townships. This upland oak forest in the rest of the township is pastured and culled, largely by the removal of the valuable white oak, and is now a more or less open stand of trees mostly from 6 to 15 inches in diameter. At its northern limit it begins as a grove of bur oaks in Section 10. Much of the bottom forest has been cleared away, some quite recently. The principal remnants are to be found in Section 25 and in the southern part of Section 11. Some 10 acres of the former on the east bank of the main branch of the Vermilion is open "walnut bottom" with trees from 10 to 20 inches in diameter, evidently from their high branching developed in a much closer stand.

A 40 acre lot of open pastured forest situated in Section 25 between the two main branches of the Little Vermilion is typical of other smaller areas. The stand is open, pastured, without undergrowth and well grassed over. Although probably originally possessing a large percentage of oak only a few bur oak trees remain and the tree population is a mixture of American and slippery elm, white and black ash, walnut, and sugar maple with a smaller number of butternut, black willow, buckeye, and honey locust *(Gleditsia triacanthos)*.

A little farther down the stream in Section 35 the white and red oaks are present but the maple and walnut practically disappear while black oak *(Quercus velutina)* and shagbark hickory become plentiful in an open stand in which numerous thorn apples *(Crataegus* spp.*)* and a few red cedar also appear. The trees are mostly from 6 to 20 inches across and oaks and hickory constitute 80 per cent of the stand.

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In the southern half of the township the stream has cut its valley so deeply that some of the steeper slopes show a tendency to gulley when they are stripped of their forest cover. Otherwise the land is almost all tillable, of good quality, and valuable for agricultural purposes.

Dimmick Township (Map II).

Here the essential features of topography observed in Troy Grove Township are repeated; the western half possessing throughout a rich prairie soil with its typical vegetation while the forested areas are confined to the eastern half where they are associated with the Little Vermilion and its tributary, Tomahawk Creek. Here the Vermilion has cut its channel to a depth of 60 to 100 feet and the flood plain reaches a width of 200 yards. With the stream valleys are associated the "timber soils," approximately 5300 acres in extent. Doubtless all of this area was originally forested but fully seven-eighths of it has been cleared and is now under cultivation or in pasture. In 1918, about 680 acres remained in forest while over 300 acres more showed stumps in a good state of preservation indicating recent cutting.

With the deeper channeling of the Little Vermilion the underlying rock is reached and in general the stream is now entrenched in a channel of either sandstone or limestone, both rocks appearing upon the slopes of the stream valley. Upon these steep river bluffs in addition to the oak, maple, basswood, etc., there appear small amounts of red cedar, white pine, service berry and water beech. The flood plains are often very completely cleared, only isolated trees of such species as walnut, elm, sycamore, ash and maple remaining.

Tomahawk Creek had originally a rather narrow forest fringe which has now largely disappeared, the isolated patches remaining constituting not more than 25 acres in Sections 12, 13, 23 and 24. These patches are much culled, closely grazed and composed almost exclusively of second growth timber from 6 to 12 inches in diameter, the principal trees, in order of their importance being bur oak, black oak and shagbark hickory.

Two groups of wood lots or forest remnants constitute the bulk of the standing timber in the township and are associated respectively with the western swing of the Little Vermilion in Sections 2 and 3 and with the confluence of this stream and Tomahawk Creek. The former amounts to slightly over 150 acres, mostly of second growth trees having a diameter of 6 to 10 inches. At least 75 per cent are oaks, the white, black and red being most abundant with smaller numbers of swamp white oak, shagbark hickory, ash and elm. Locally the stand is fairly close but grazing is so heavy that there is no evidence of any reproduction during the last two decades. Stumps scattered through pastures prove that the area recently cut over exceeds that of standing timber.

Through the southern half of the township the flood plain is partially cleared but some open stands of ash, sycamore, cottonwood and elm remain in narrow strips. The one exception is within the angle formed by the Vermilion and Tomahawk Creek in Section 34 where 50 acres are rather closely covered with a mixture of bur oak, elm, ash and walnut, with smaller amounts of butternut and sycamore. Willow, wild crab and prickly-ash form most of the undergrowth.

This township resembles many adjacent ones in having all the larger forest areas of the upland oak type beginning with some 60 acres of fairly good timber just north of the road bisecting Section 26 and lying on both sides of Tomahawk Creek. Black oak is the most abundant, trees of bur oak, white oak and shagbark hickory mingling with it. South of the road the stand becomes in many places more open with smaller trees; few exceeding 10 inches in diameter. This forest continues into Sections 34 and 35, there covering 200 acres with pastured oak forest.

Earl Township (Map III).

This is a prairie area intersected by Big Indian Creek, which has developed a shallow stream valley, the gentle slopes of which show the characteristic upland timber soil (No. 1134 of the Soil Report). South of the village of Earlville a flood plain varying from 50 to 200 yards in width has been developed, composed of mixed loam (No. 1454) which was originally as completely forested as the

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timber soil. The combined area of these soils is, according to the maps of the Soil Report, approximately 3,200 acres a little less than 25 per cent (850 acres) of which now possesses tree growth dense enough to be termed forest. A reference to the earliest township maps shows that all the timber soil was originally forested and that it was divided into wood lots varying in size from 5 to 20 acres. Township records show that these were owned and used as a source of timber and firewood, for the most part, by farmers living on prairie farms in other parts of Earl or adjacent townships, often at a distance of 10 or even 20 miles. As these lots were cleared some passed from the hands of the original owners and formed parts of larger cultivated fields or pastures. So extensive and so intensive has been the grazing that not more than 40 acres show evidence of reproduction. The principal ungrazed remnants are in Sections 8, 17 and 20. The wider extent of the upland timber soils and the consequent dominance of wood lots and forest areas upon the east side of the stream are here very notable and are discussed elsewhere.

The cutting has been so extensive, even within the area still forested, as to obscure to a large extent the character of the original woodland but everywhere oaks seem to have predominated. A possible exception may be found upon the bottom lands southeast of the village of Earlville. Here for a distance of two miles or more there remains a fringe having an average width of 150 yards, in addition to the isolated areas indicated upon the map. This strip is populated, to a large extent, with trees of rather large size—10 to 20 inches in diameter—the density of the stand varying from a condition in which trees with tall straight trunks have lightly touching crowns to open pasture having 10 to 20 broadly spreading trees per acre. In these areas the species are mostly ash and maple with a large admixture of the oaks and towards the southern part of the township a sparse scattering of hackberry, sycamore, walnut and locust *(Robinia)* with occasional patches of thorn apple and papaw. "Walnut bottoms' were either originally absent or else have been entirely denuded.

The upland oak forest as shown by its remnants formerly exhibited three rather distinct types: (1) The dry oak upland where black and bur oaks were found, (2)

the rich upland and (3) the flat upland. The first is seen typically in the south half of a tract northeast of Earlville (Map III, a) where along with black and bur oaks are found such shrubs as choke-cherry, panicled dogwood, hazel nut and New Jersey tea, while among the herbaceous plants are sunflowers, horse gentian, asters and golden rod. Another area of this type is seen in Section 21 (Map III, b).

The flat upland oak type is not extensively developed but is seen in a 40 acre tract in Section 17 (Map III, c). The essential feature of the soil is poor drainage and while oaks still predominate a list of tree species beginning with the most abundant and passing gradually to the least would be: bur oak, white ash, elm, black oak, basswood, red oak, walnut, butternut, Hill's black oak *(Q. ellipsoidalis),* white oak, sugar maple, bitternut hickory and shagbark hickory.

Before cutting began the rich oak forest was probably the most abundant type and a well preserved ungrazed area of some eight acres in Section 20 (Map III, d) now seems to represent a condition approaching somewhat nearly to that which existed formerly over a very considerable portion of the timber soil. Here white and red oak predominate, and sugar maple comes next in abundance, there are scattering trees of white ash, basswood, elm, and black walnut with an occasional shagbark hickory and mulberry. The red-berried elder and the prickly ash among the shrubs and blood root, hepatica, phlox, water leaf and the broad leafed sedge in the undergrowth, all indicate the climax richness of this forest. While the absence of trees more than two feet in diameter indicates that some cutting has occurred, there seems to be good evidence that there has been none during the past 30 or 40 years.

Few of the areas show clean cutting and subsequent reproduction, the usual range of sizes being from 8 to 18 inches, grazing having kept down reproduction for many years. Two tracts, however, in Sections 4 and 27 (Map III, e, f) show a second growth stand, trees ranging from 4 to 8 inches across dominating the area.

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Freedom Township (Map III).

The valley of Big Indian Creek upon leaving Earl traverses the northeast corner of the prairie township of Freedom. Associated with this stream are 1500 acres of timber and bottom land soil that were doubtless originally very completely covered with forests. These have been so completely cut off that it is only by a most liberal interpretation of what constitutes a forest that we are able to include within that category as many as 120 acres of woodland. Scattered stumps still persist over an almost equal area. The stream valley is here about 60 feet below the level of the upland and the flood plain about a hundred yards in width. This flood plain is very completely stripped of trees, only isolated specimens being scattered here and there. Among them were noticed Kentucky coffee trees, blue ash *(F. quadrangulata)*, sycamore, elm, and papaw *(Asimina triloba)*.

The forest remnants are of the upland oak type into which some of the bottom forest trees have intruded. Culling has taken out much of the better timber and in the open stand maple, elm and ash are nearly as plentiful as oak. All the areas are grazed and no reproduction is in progress.

In Section 3 on the east bank of the stream there is a small area of about 10 acres marking the site of an Indian massacre that took place in 1830. In 1906 this tract was made a state reserve under the name of Shabona Park. The few trees on this plot are so scattered that the term forest scarcely applies.

In the southeast corner of the township, Section 36, a fringe of possibly 5 acres of mixed forest borders Crooked Leg Creek.

Adams Township (Map IV).

Little Indian Creek flows southward in a winding course through the center of this township and with it are associated about 2400 acres of upland timber and bottom land soils, 90 per cent being of the former type. Upland prairie soils form the slightly undulating surface of the remainder of the township, the brown silt loam (1126) predominating with occasional patches of darker color (1125).

The woodland, at the date of survey, covered about 175 acres almost wholly of the upland oak type, more than half of which occurs in two scarcely separated areas in Section 26 and 27. The trees are mostly of medium size, showing culling and a lack of reproduction during recent years, due to the almost universal intensive grazing.

In the southern part of the township, Section 35, the immediate stream valley has a narrow strip of mixed bottom forest, continuous with that in Serena township.

Serena Township (Map IV).

While the county maps show the Fox River as the eastern boundary of Serena township this report covers only that major portion which is included in Township 35 North, Range 4 East. Along the Fox River at the south, terrace soils are found near the stream but as they are now largely forested they are included with the bottom land and upland timber soils in the potential forest area which is approximately 7000 acres, or about one-third of the entire township. Less than one-fifth of this area is at present forested for, with a most liberal estimate of what shall be regarded as forest, trees cover approximately only 1300 acres. As in other townships the flood plains are largely cleared, the principal remnants of bottom forest being a narrow strip in Section 3 made up principally of elm, bur oak and walnut, a few acres in Section 8 with elm, ash, basswood and sugar maple, and some larger areas in Section 16 associated with Big Indian Creek and with its confluence with Little Indian Creek. Here the stand is so very open as to be appropriately termed an orchard flood plain pasture, the tree species in order of abundance being bur oak, sugar maple, black walnut, elm, sycamore, locust *(Gleditsia)*, black willow, butternut, bitternut, hickory and papaw.

Section 3 also shows the largest area of dry oak forest, about 4 acres being found west of the stream and near the tracks of the C. B. & Q. Railroad, while another strip of similar character, also upon the west side of the stream, runs through Sections 28 and 32. The black oaks dominate, both species *(Quercus ellipsoidalis* and *Q. velutina)* being present, while associated with them are smaller quantities of white and chestnut oak *(Q. Muhlenbergii)*, and even an occasional shingle oak *(Q. imbricaria)*.

The oak upland is, as usual, the most abundant type covering at least 75 per cent of the timbered area. Occasionally the grazing is not heavy yet there are no instances of good reproduction in progress. The large block in Section 33 has been heavily culled in the past but now has a fairly good stand of mixed white, black and red oak with an occasional hickory, the sizes running from 6 to 10 inches for the greater portion of the area, with some clumps of larger trees in the outskirts.

There is here a rather rank undergrowth in which sunflowers, thoroughwort, New Jersey tea, bitter sweet of shrubby habit, *(Celastrus)* and hazel-nut are conspicuous. ous.

A tract of about 4 acres, north of the Fox River, in Section 35, seems to be practically ungrazed. In the eastern part of the same section are some good stands of second growth white oak 2 to 8 inches across covering some 10 acres. Here, too, along a tributary ravine a much culled forest has recently been swept by a cyclone overturning most of the trees spared by the choppers.

The steep slopes of the stream valleys have a mixed stand with Arbor vitae, red cedar, an occasional white pine, hop hornbeam and service berry on the more exposed portions and oak, maple and basswood on more sheltered slopes. Where much cutting has thinned the trees such shrubs as black haw *(Viburnum prunifolium)* and sumac constituted much of the scrub cover. Many of these steeper slopes gully badly when the tree cover has been removed.

Dayton Township (Map IV.)

The parts of the township included in this report are Sections 1, 12, 13, 24, 25 and 36 and the eastern half of Sections 2, 11, 14, 23, 26 and 35, Range 3 East and Sections 3 (in part), 4, 5, 6, 7, 8 and 9 in Range 4 East which together comprises about 15 square miles. The timber soils are here developed on the right bank of the Fox River and in connection with its tributaries Indian, Crooked Leg and Buck Creeks. These soils cover rather more than one-third of that part of the township under consideration or approximately 2900 acres, 450 acres being forested. It is certain that a survey of the remainder of the township will add very little to the forest covered area.

The usual oak upland type with medium sized trees covers two-thirds of the area (developing upon the timber soil along the creeks). It is heavily grazed and shows little or no reproduction. Upon the slopes of the stream valleys in Section 3 and 4 cutting was in progress at two points, the trees being converted into fence posts and mine timbers.

La Salle Township (Map V).

Although a small township, extending only three miles from east to west, La Salle exhibits a considerable diversity of topography on account of its bisection by the Illinois River. This stream divides it into three distinct regions consisting of a broad, flat river valley flanked on the north and south by steep slopes leading to uplands nearly 200 feet above the level of the stream. South of the Illinois River the eastern boundary of the township is the winding course of the Vermilion River which joins the Illinois about one mile southeast of the city of La Salle.

According to the maps of the soil survey the "timber soils" occupy approximately 4,500 acres and the bottom lands slightly over half (2,300 acres) that amount. Upon the former soils are situated the city of La Salle and the village of Oglesby and this, together with the areas cleared and under cultivation, reduces the area actually covered by tree growth to not more than 800 acres including many half-denuded slopes.

By far the largest continuous area is along the Little Vermilion and more especially upon the east side of the stream in Sections 2 and 1. In the former the stream has a flood plain over 300 yards wide but this has been largely cleared and is now being cultivated, the forest being restricted to the steep bluffs bordering the valley, to the tributary ravines and to portions of the immediately adjacent uplands. This reduces the bottom forest to a vanishing remnant and results in the dominance of the oak upland forest in which the white oak is conspicuous. Upon the steeper slopes red cedar, hop hornbeam, basswood, service berry *(Amelanchier)* and an occasional white pine are to be found, while towards the foot of the bluffs some trees of the bottom forest occur.

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In Sections 10 and 11 the occurrence of the more resistant limestone causes a narrowing of the stream valley and the almost complete disappearance of the alluvial flood plain. The floor of the valley is rocky and irregular and while not cultivated is stripped of most of its timber. Small bur oaks, cottonwood and sumach, with smaller numbers of the species named above form an open scrubby cover, the size of the trees increasing upon the slopes.

Upon the upland in Section 11 the forest passes into an open oak pastures with trees 1 to 20 inches in diameter. Portions of the valley and upland are known as "Matthewson Park" and have been used to some extent as a picnic ground. The rugged topography unfits this area for cultivation, but the limestone cliffs and rocks and the open forest could find no more fitting function than that of providing a pleasure resort for the adjacent city.

In Section 13 the portions north of the old Illinois and Michigan Canal are mostly covered with the remains of an oak forest, which extends northward into Section 12 along two small streams. The river bluff and slopes of the ravines have the usual mixed type in which oaks predominate. The red-bud, *(Cercis canadensis)*, and the hackberry, *(Celtis occidentalis)*, are common especially near the triangulation point, while upon the edge of the canal willows are frequent. An open oak forest, well grazed, occupies the more level upland in which are found in addition to the usual white, red, and bur oaks specimens of black oak *(Q. velutina)*, Hill's black oak, *(Q. ellipsoidalis)* and shingle oak, *(Q. imbricaria)*. The more open areas show sumach, service berry, bush honeysuckle *(Diervilla)* New Jersey tea *(Ceanothus)* and a prickly pear cactus *(Opuntia)*.

Any critical study of the vegetation of the flood plain of the Illinois River must be reserved for a future report, but it may be noted that upon the north side of the stream the forest growth consists only of a few patches of rather small black willows, one such patch of some two acres lying east of Split Rock just south of the canal. A larger area where willows are mingled with river maple occurs along the railroads just north of Oglesby. The total area of this stream side forest within the township does not exceed 50 acres.

South of the Illinois River the forest is limited almost exclusively to the steep slopes of the river valleys. Such areas include fringes along the Vermilion River for nearly 5 miles of its winding course and front the Illinois River valley for 2 miles. In steepness of slope and in width this strip varies much but it will average nearly 200 yards. In the character of its soil it is even more uneven, exhibiting both rock outcrops and clay slopes. While it is difficult to estimate the extent of such an irregularly shaped area it is probably not short of 300 acres, although along the Vermilion River where the slope carries the Illinois Central Railroad the cover is often little more than scrub. The chief stand is a mixture of the oaks of the upland and the species of the river bottom. The only place where the adjacent upland oak forest remains is near the village of Deer Park where there are still some 25 acres of pastured forest with black and bur oak more abundant than the red and white.

Cedar Creek curves into Section 34 and although its flood plain is here cleared its steeper slopes and tributary gullies add 75 acres of culled and pastured oak forest.

Notable features of the forested areas of this township are their scattered distribution and the fact that the soil they occupy is for the most part quite untillable.

Peru Township (Map V).

Lying west of La Salle Township and on both sides of the Illinois River, Peru Township shares the topographic features of its neighbor. It is only 3 miles across, consisting of the west half of Township 33N., Range 1E. Its surface consists of the usual upland prairie intersected from east to west by the timber and bottom soils associated with the Illinois River valley. The former soils occupy the slopes and tributary ravines and approximate 3800 acres, the largest area bordering Cedar Creek. The bottom lands, forming the floor of the Illinois River Valley amount to about 2000 acres. Of this entire area of 5800 acres, probably all originally in forest, trees remain on about 800 acres, and 90 per cent of the existing forests are upon the upland soil.

The timber soils in the northern portion furnish the site for the town of Peru and have been almost entirely cleared, the remnants consisting of a few acres (10) on the

slopes of the Illinois valley in Section 19 and portions of the two ravines in Sections 16 and 17, together covering 50 acres. In the ravine immediately north and east of the town of Peru the open pastured forest is conspicuous for the predominance of the buckeye, while the open stand associated with the ravine nearer to the city of La Salle is largely composed of bur oak.

The wide flood plain of the Illinois River is cleared and cultivated with the exception of a few wet depressions. The road leading from the town of Peru southward across the plain is bordered by a fringe, partly planted, of river maple, cottonwood and black willow while just west of the road on the Sections 29 and 30 is a stand of stream side forest in which river maples 4 to 10 inches in diameter constitute 75% of the stand. With them are associated white ash, elm and black willow and the typical undergrowth of smaller willows, button bush and such herbs as swamp docks *(Rumex spp.)*, smartweeds, wood nettle *(Laportea)* and swamp rose mallow *(Hibiscus militaris)*.

On the south side of the Illinois River flood plain steep slopes go up to the rolling upland 200 feet above. These slopes are dissected by ravines the principal one being cut by Cedar Creek, while two smaller streams west of and parallel to this stream have eroded similar steep-sided valleys. The forested areas are almost wholly confined to these slopes and ravines. Only along Cedar Creek has a flood plain developed and here it is limited to the lower half of the stream. It has been cleared with the exception of a few (5) acres of walnut bottom in Section 33, with trees 6 to 12 inches across, and a smaller portion farther up the stream with a mixed stand of elm, sycamore, walnut, hickory, buckeye and cottonwood with a frequent occurrence of thorn and crab apple as undergrowth.

The remainder of the forest is of the upland oak type. The largest area of a nearly closed stand is to be seen near the foot of the Cedar Creek valley upon the right slope and in the ravine of a tributary stream at the left. This is second growth with trees having diameters of 2 to 8 inches, white and red oak and the red-bud *(Cercis)* being particularly abundant. Towards the head of the tributary stream black and bur oaks mingle with white and red in a similar grazed stand.

Associated with the second ravine the northwest quarter of Section 32 is covered with what may be termed oak-orchard forest consisting of large white oak (10 to 30 inches) with low branched spreading crowns, the outermost branches scarcely touching one another.

The rest of the stand in Sections 32 and 31 is definitely within the stream valley and consists of white, red and chestnut oak with which are mingled as the stream is neared some maple, basswood, ash, buckeye and sycamore. This is a similar mixture to that found in the western half of Section 31 except that here culling has been more severe so that little good timber remains.

The slopes of the Illinois River valley and those of the tributary streams have so steep a gradient that the removal of the existing forest will increase erosion and gullying to a decided extent.

Vermilion Township, in part (Map V).

A small portion only of Vermilion Township was covered in this survey and only a portion of Sections 6, 7, and 8, Township 32N., Range 2E., are included in the map accompanying this report. They are entirely covered with timber and terrace soils, the area being slightly over 1000 acres, one half of which still remains in forest. This forest is principally of the oak upland type mixed immediately along the edge of the Vermilion River with certain of the usual flood plain species.

In the eastern half of Section 7 is a block of nearly a quarter section in extent that although somewhat culled, has been untouched by grazing and hence shows reproduction and a normal undergrowth of shrubs and herbs. Upon the more sheltered slopes maple and red oak are common and many trees of good size remain. The very decided richness of these slopes is shown by the presence of such plants as *Hepatica acutiloba,* the ginseng, *(Panax quinquefolium),* the baneberry, *(Actaea alba),* the poke milkweed, *(Asclepias phytolaccoides),* the water leaf, *(Hydrophyllum virginianum)* and such ferns as the beech fern, the maiden hair, and the golden spleenwort *(Asplenium acrostichoides.)* Notable among the shrubs are the goat's beard, *(Aruncus sylvester)* and the hydrangea *(Hydrangea arborescens.)* The richness and beauty of this forest are such that it deserves, along with the neighboring Bailey's Falls and Deer Park, to be made a permanent park.

SUMMARY BY TOWNSHIPS OF THE TIMBER SOIL AND FORESTED AREAS.

Township	*Timber soil* (Acres)	*Forest* (Acres)
Mendota	0	0
Meriden	150	75
Ophir	750	200
Waltham	600	20
Wallace	60	20
Troy Grove	2600	500
Dimmick	5300	680
Earl	3200	850
Freedom	1500	150
Adams	2400	175
Serena	7000	1300
Peru	3800	800
La Salle	4300	800
Dayton (in part)	2260	250
Vermilion (in part)	1100	540
Totals	35020	6530

SUMMARY.

1. This report covers the forest survey of 16 townships (3 in part only) in the northwest portion of La Salle County, Illinois, covering an area of approximately 440 square miles.

2. In these townships the potential forests, as represented by the distribution of the upland timber and terrace soils, amount to an area of approximately 35,020 acres, or 12.5% of the total area covered by the survey.

3. The total forested area is approximately 6,530 acres or 2.3% of the area included in the survey.

4. About three-fourths of the woodland area belongs to the upland oak forest type, the remaining fourth including areas of dry oak, rich bottom and mixed forest types.

5. Grazing is so universally practiced and so intensive in its character that not over 5% of the oak and bottom forests show reproduction in progress at the time of the survey.

6. Along many of the stream valleys are slopes of such a character that the removal of the forest cover will cause and in some cases has already caused, rather extensive gullying.

STRIP SURVEY AND GROWTH STUDIES IN LA SALLE COUNTY.

R. B. Miller, State Forester, and Geo. D. Fuller,
University of Chicago.

During the week of Sept. 15th to 20th it was possible to run some strip surveys in some of the forest tracts previously located by Dr. George D. Fuller in La Salle County which were representative of the types of this region. The results of these strip surveys are given in the following pages appended to Dr. Fuller's report, and for convenience are lettered from A to I, in the order in which they were made.

The method was that of the ordinary strip survey familiar to all foresters and estimators of timber and was carried out with a crew of three men, one compassman and two estimators. The compassman, with a 4-rod tape attached to his belt, ran the compass across the tract and tallied the trees according to diameter and species as they were called out to him by the men on each side, who covered each a strip 33 feet in width. When the party had advanced a distance of ten chains, or 40 rods, an acre of ground had been covered. The estimate as made up from these strip acres was then applied to the tract as a whole. This method does not differ from the laying out of "quadrats" by the ecologist, each unit being an acre 10 chains long and 66 feet in width. It has the advantage of taking one across the tract and allowing a map of types or physical features to be made which in small woodlands is hardly necessary, conditions being of such uniformity. When the strips are run a distance of 10 chains or 660 feet apart, one-tenth of the tract or "forty" has been covered, giving a ten per cent estimate.

All trees were calipered at breast height, or 4½ feet above the ground and as the party progressed notes were made on reproduction, ground cover, and herbaceous vegetation. The tally sheets, with the distance traversed, are retained and the estimate is made up in the office from

board foot volume tables based on diameter breast high and number of sixteen foot logs. Such a table is found on page 22 of Farmer's Bulletin 715, U. S. Department of Agriculture, "Measuring and Marketing Woodlot Products", which also gives a full description of the strip method of estimating timber and working up the contents by means of volume tables, based on the Scribner rule.

Brief Description of Tracts Estimated.

Tract A. *Oak-Hickory Forest.* (Serena Township, Sec. 33).

This tract was located on the road about three miles from Wedron and grazing had been lighter in it than most of the others in that region. Some scattered cutting of small white oak for mine props had been done and the heavy growth of hazel and raspberry bushes in some places showed that cutting had been too heavy. Good corn was growing on an adjacent part that had been cleared, indicating good soil. Omitting the tally sheet for 4.7 acres of strip survey, the main facts are about as follows:

Average number of trees per acre 203
Number of trees 3 inches in diameter or less... 48 per acre
Stand per acre ..... 2,208 board feet.

Per cent of species

White oak	64%
Black oak	19.5%
Shagbark Hickory	14.6%
Bur oak, Red oak, Cherry	1.9%
Total	100.0%

Tract B.—*Upland dry oak forest.* (Serena Township, Sec. 33).

The stand here was composed mostly of white, black and red oak, with some basswood and elm in the wetter portions. Judging from scattered poplars, the signs on the trees, the growth of golden rod and absence of humus it seems that the forest had been repeatedly burned. While at first appearance it would not rank with tract A, the volume really ran higher because of the presence of more medium sized trees. It was unfenced and was the common

type of forest being cut off in that region for mine props. The soil was a yellow gray silt loam, average corn land.

Average number of trees per acre 197
Number 3 inches in diameter or less 62
Stand per acre.....3,018 board feet.

Per cent of species.

White oak	65.6%
Black oak	28.4%
Red oak	1.7%
Hickory	1.8%
Cherry, Basswood, Bur oak	2.6%
Total	100.0%

Tract C. *Ravine forest—Indian creek.* (Serena Township, Sec. 28).

A strip was run for eight chains down a ravine and across a small brook to get some idea of the timber on rough land along small streams. The tally sheet showed that on the ravine sides, where conditions were more mesophytic, black oak gave way to red oak, with an occasional hard maple. Red oak being a fast grower and the ground too rough for tillage it would not pay to pasture such places but to leave them in timber. In the bottom were found a few black cherry, walnut and ash trees.

Average number of trees per acre 183
Volume per acre.....3,379 board feet.

Composition of stand

White oak	20.2%
Red oak	47.0%
Bur oak	11.7%
Miscellaneous	9.4%
Total	100.0%

Tract D. *Woodland Pasture.* (Peru Township, Sec. 32).

This was an excellent example of the woodland pasture in La Salle county, being of about 10 acres in extent and of an open park-like appearance. It has been constantly pas-

tured and only six three-inch trees were found in the 8 acres of strip, those being in ravines. The trees were very short boled, most of them making not over one 12 foot log. Some cutting had been done for fence posts and the diameter growth of such open grown trees had been rapid, some trees having grown 2 inches in radius in ten years. Trees 13 inches in diameter on the stump were from 50 to 55 years old.

Per cent of species

White oak	58.7%
Bur oak	12.8%
Shagbark Hickory	13.7%
Others	14.8%
Total	100.0%

Number of trees per acre 46
Average board feet per acre 1881

Tract E. *Ravine Forest*—Illinois river (Cedar Creek. Peru Township, Sec. 31).

Ravine type. This is about the only place where maple is found in abundance. This strip included the bottom of a small ravine and the side of the ravine, running out to oak hickory forest at the top of the ridge. Had been pastured and trees are larger than *C*, hence estimate runs higher. On the sides of the ravine are good conditions for reproduction if stock were excluded as acorns are lying on exposed mineral soil and only need a slight covering to germinate. As shown by the tally sheet, the number of species is quite large for a small area but red oak and rock maple are the dominant species. Such ravines should be kept in timber and grazing prohibited. It is such ravines that show up as the forested areas on the topographic sheets of the Geological survey.

Average number of trees per acre 115
Volume per acre .....3,855 board feet.

Per cent of species

Red oak	20.8%
Hard maple	30.6%
Others	49.6%
Total	100.0%

Tract F. *Bottomland Woods,* Vermilion Creek. (Troy Grove Township, Sec. 14).

This was one of the best tracts of timber examined, so far as natural forest conditions were concerned, lying at the head of Vermilion creek. Along the stream the soil was a brown silt loam, changing to yellow gray silt loam on the higher parts. The woods was only lightly pastured and the tally sheets show that there were 40 trees of the three-inch diameter class, mostly ash, elm and walnut.

Per cent of species

White elm	23%
White oak	18%
Red oak	11.1%
Maple	11.1%
Bur oak	9.0%
Ash	8.0%
Red elm	8.0%
Others	11.8%
Total	100.0%

Average number of trees per acre 135
Stand per acre ..... 4,625 board feet.

Tract G.

This was a tract adjoining Tract F, but was deteriorating through the effects of neglect and cutting. This was evidenced by the undergrowth which made travel through the woods difficult. Reproduction consisted of elm and ash, with bur oak taking the place of white oak in the lower parts of the area. The tract was badly in need of an improvement cutting to remove straggling wide-spreading trees which were crowding better ones underneath. Evidences of recent pasturing were not so evident and there were 41 three-inch trees per acre.

Per cent of species

Bur oak	23.9%
Elm	22.7%
Red oak	13.2%
White oak	13.1%
Ash	10.9%
Others	16.2%
Total	100.0%

Average number of trees per acre 124
Average stand per acre ..... 4,510 Board feet.

Tract H. (Vermilion Township, Sec. 6, Above Vermilion River).

This was rather a thin stand of white oak, bur oak, black oak and shagbark hickory, on upland soil, just past Bailey's Falls. Some cutting had been done recently, and hazel brush, blackberry bushes and asters formed the main undergrowth. The stand, as was found from ring counts on stumps was from 75 to 80 years old. The trees were short, not averaging more than 1½ sixteen-foot logs per tree, reproduction consisting mostly of white oak and black walnut.

Average number of trees per acre 122
Number of 3-inch trees..... 5
Volume per acre ..... 2,573 board feet.

Per cent of species

White oak	67.2%
Black oak	20.0%
Shagbark Hickory	5.0%
Others	7.8%
Total	100.0%

Tract I. (Sec. 7, Above Vermilion River).

This was one of the best stands examined, so far as forest conditions were concerned, but did not average quite so high as tract F. The tract comprises about 160 acres, and the leading species in order are white, black, and red oak. The soil is a brown silt loam and the ravines were deep enough to give some little difference of forest composition due to soil moisture, so strips were run across the ravines.

Grazing had been light and there were about 26 three-inch trees per acre. Seedlings consisted of elm, ash, and white oak, the latter being where openings had been made in the stand by cutting. Clear length was good, and trees would make about two 16-foot logs per tree. The humus was about three inches deep, well decayed with a layer of hardwood leaves on top. The composition of stand was as follows:

White oak 60.2%
Black oak 14.5%
Red oak 12.0%
Others (Ash, elm,and maple) 13.3%

Average number of trees per acre 146
Average volume per acre ..... 4,307 board feet.

STUMP ANALYSES.

On September 15th and 16th there was an oportunity afforded to get an idea of the growth of white oak in the ordinary woods pasture on light gray silt loam above Indian Creek and 37 trees were analyzed and others measured for volume, where men were cutting trees for mine props and piling. In addition to an estimate on Plot 1 in a similar site about a quarter acre of ground was measured and all material that had been cut on it was counted and the piles separately measured to determine their volume. The number of trees was too small to form any definite conclusions as to growth but are included as giving some idea at least of the growth and yield in this class of timber; which is much larger than the average farmer believes. Actual products measured on an acre were as follows:

Material	*Length*	*Number*
Fence posts	8 feet	116
Piling	25-30 feet	36
Mine props	7 feet	312
Mine props	5 feet	2042

The total number of trees per acre on land of this class which was light gray silt loam soil of poor fertility for agriculture was 214, with an average height of 40 feet and an age of from 55 to 75 years.

The value of the land for pasture would not be over $4.00 per acre. There was no reproduction on account of pasturing and when cut over this land would be liable to erosion, on account of its high situation above Indian Creek.

Measurements on 37 white oak trees cut and peeled for piling showed the following heights to a six-inch top diameter:

Diameter Breast High (Inside Bark) Inches	Merchantable Length (feet)
8	20
9	24
10	30
11	35
12	40
13	48

The average diameter growth on the stump for these same 37 white oak trees was 1.7 inches for the last decade, a very good growth for this class of soil.

Products from Forests of the Ottawa Region.

Piling.

According to the men cutting piling, the only species which would be accepted are white oak and bur oak. Piling must have a butt diameter when peeled of not less than 13 inches, with a 7 inch top. The length must be not over 50 feet, nor less than 20 feet. The men receive 1½ cents per linear foot for cutting and peeling. Piling is sold at a stated price per linear foot for specified dimensions, the price increasing rapidly with increase in length and in desirability of form or taper. One acre of average white oak in this country would produce, according to our estimate and by actual count on the ground about 875 linear feet of piling, with an average length of 25 feet. A white oak tree 16 inches in diameter inside the bark on the stump will produce a pile 40 feet in length and top diameter of 6.5 inches, with a volume of 29.2 cubic feet in about 76 years, or an annual volume growth of .384 cubic feet.

Mine Props.

Mine props are cut from any species, except poplar, and may have the following sizes:

Length (feet)	Diameter of top end (Inches)	Price paid for cutting
4	3	.1 cent each
5	4	1.5 cents each
7	5	5. cents each

Props are usually split from the larger cuts of white oak of a length of four or five feet, and since they are in greater demand, a seven foot round prop is obtained whenever possible in measuring up small trees. A white oak with a breast high diameter of 11 inches and a clear length of 50 feet will make six cuts, averaging six props per cut, or thirty-six for the tree. Props are split out with maul and wedge (four and five foot) while the seven foot props are not split.

Fence Posts.

Fence posts are cut and split from straight-grained white oak, to a length of 8 feet, and men receive 5 cents each for cutting them. One 16-inch white oak (on the stump inside the bark) will turn out from 20 to 23 posts. Fence posts of white or bur oak are worth from 20 to 25 cents each, and on one acre, in addition to props and piling there would be 116 split fence posts.

THE FORESTS OF VERMILION COUNTY.

W. B. McDougall, University of Illinois.

INTRODUCTION.

The area considered in the following pages consists of about 25 square miles in the middle western part of the Danville quadrangle in Vermilion County, Illinois, and includes parts of Blount, Oakwood, Danville and Catlin townships. It is cut by both the main branch and the middle fork of the Vermilion River and also includes parts of several valleys tributary to the north fork of the same river, so that much of the area is very hilly.

Practically the entire area is underlain with coal and this fact has had considerable influence on the economic development of the region. Numerous coal mines are being worked at the present time and numerous others have been worked in the past and then abandoned. Considerable areas are owned by the various coal companies and in these all other interests have been subordinated to those of coal mining. In several instances villages have sprung up where new mines have been opened and after a number of years the mines have been "worked out" and the villages have disappeared, only to spring up again in some other locality. Often in the vicinity of these temporary mines the miners and their families live in shacks that appear wholly inadequate for the health and comfort of the occupants. Agriculture is of course, next to coal mining, the most important industry of the region and the greatest percent of the more level places is under cultivation.

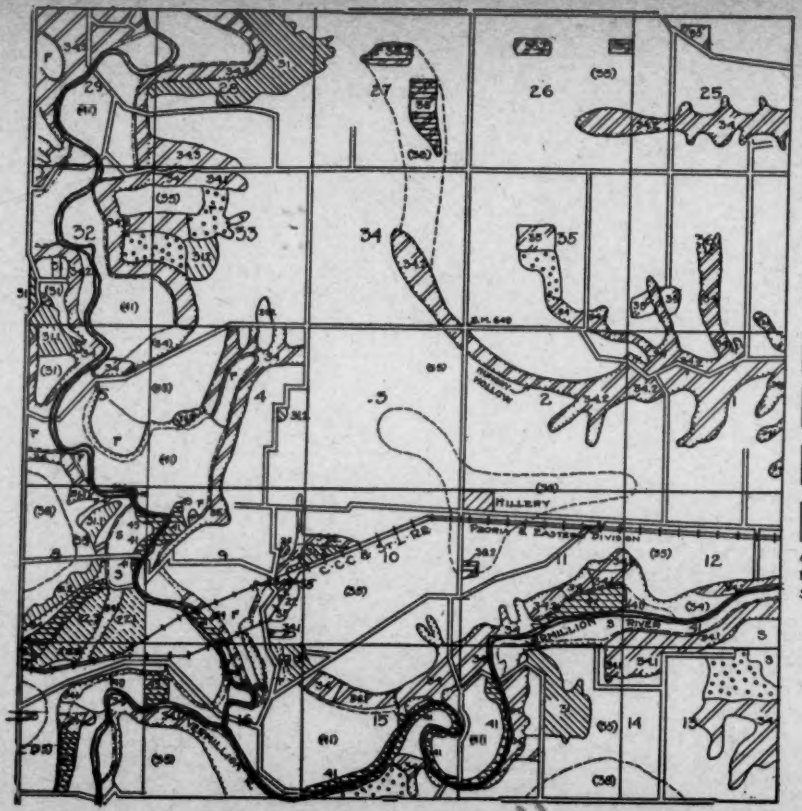
The soils of this region are very largely of four types.[1] Most of the upland soil is either brown silt loam or yellow-gray silt loam. The yellow-gray silt loam is an upland timber soil and was all formerly covered with forests. A very high per cent of this soil, however, has been

[1] Te writer is indebted to Professor J. G. Mosier of the University of Illinois for all information concerning soils.

cleared and is now under cultivation. Brown silt loam is an upland prairie soil. It also was formerly partly, if not entirely, covered with forests but it became occupied by forests at a more recent time than did the timber soil and the forests were of a different type, as will be shown later. Like the yellow-gray silt loam, the brown silt loam has been mostly cleared and is under cultivation but remnants of forest are found on it here and there. The slopes and ravines are largely covered with yellow silt loam, which like the yellow-gray silt loam is an upland timber soil. In some places this soil also extends back on to the upland for some little distance from the slope. The most of this soil is still covered with forests, as a result of its being too broken for agricultural purposes. The bottomlands are occupied almost entirely by mixed loam, a bottomland soil. All of this was formerly covered with forests and while the larger areas have been cleared and are under cultivation many of the smaller patches are still forested.

Explanation of Map.

Plant communities, including forests, are often classified into three groups. Those that occupy the higher elevations where the supply of soil water is inadequate for many kinds of plants are said to be xerophytic; those that inhabit the lower places where the water supply is abundant are called hydrophytic; and those that live in the intermediate positions where the amount of soil water is moderate but adequate are spoken of as mesophytic. On the accompanying map, numbers from 2 to 29 are used to designate forest associations that are more or less xerophytic; numbers from 30 to 39 indicate forests that are more or less mesophytic; and numbers from 40 to 59 refer to forests more or less hydrophytic. The different tyes of forests in these three groups will be described separately. In all cases a whole number, as 34, indicates a virgin forest of good sized trees; a fractional number with .1, as in 34.1, refers to a second growth forest consisting, therefore, of small trees; a fractional number with .2, as 34.2, means a very thin and open forest of good sized trees; and finally a fractional number with .3, as 34.3, indicates a forest area within which there are small irregular cleared patches which may be under cultivation. A letter F on the map indicates land which has been cleared but which



Forest Survey Map
of
25 Square Miles
Danville Quadrangle
Vermillion County, Illinois.
by
W. B. McDougall

- 22 — Xerophytic Forest Or Dry Forest — Sassafras and Sassafras-Hickory Association.
- 31 — Mesoxerophytic Forest — Oak-Hickory Association
- 34 / 35 — Hillside Transitional Forest — Xerarch-Mesophytic Forest — Beech, Maple, Red-Oak Association
- 36 — Hydrarch-Mesophytic Forest — Basswood-Elm Association
- 41 / 42 — Hydrophytic Forests — 41 Elm, Sycamore, Maple Association — 42 Cottonwood-Willow Association
- 51 — Forests Of Undrained Depressions — Cottonwood-Willow-Slough Association
- Upland, Hill Slopes, Bottom Land
- Stumpland

( ) Forest Type Originally Present
F Land Suitable For Forests
S Land That Has Been Stripped By Coal Companies.

in the opinion of the writer ought to be forested. Numbers in parentheses, as (35), show the type of forest which formerly occupied areas that have been cleared and a letter S indicates "stripland" which will be spoken of again later.

Forests.

Xerophytic Forest Associations.

The Sassafras and Sassafras-hickory associations (22, 22.1 and 22.3). The only parts of the region studied which bear xerophytic forest associations are two areas occupying portions of the southern part of section eight and the northern part of section seventeen and a small area in section nine. The two areas first mentioned which were formerly covered by more mesophytic forests are owned by the Missionfield Coal Company. They have been entirely cleared at some time in the past and cultivated to a certain extent and then left as waste land. The area numbered 22.1 is entirely covered by a young sassafras association in which *Sassafras varifolium*[2] which is the dominant species is accompanied by patches of blackberries, New Jersey tea *(Ceanothus americanus)*, hazelnut *(Corylus americana)* and a few young white oaks *(Quercus alba)*. The other area, numbered 22.3, is the same except that there are several irregular patches that are still under cultivation.

The area in section nine numbered 22 is not owned by a coal company and has never been cultivated, but it has not been persistently pastured since being cleared and is now occupied by a sassafras-hickory association, the hickories all small *(Carya ovata* and occasionally *C. cordiformis)*.

Mesophytic Forest Associations.

The oak-hickory mesoxerophytic association (31, 31.1, and 31.2). This forest association is spoken of as mesoxerophytic because it is in a sense intermediate between the xerophytic and mesophytic types. It occurs on yellow silt loam, where this soil extends back from slopes on to uplands. The dominant trees are white oak *(Quercus alba)* and hickories *(Carya ovata* and *C. cordiformis)*. These are accompanied by black oak *(Quercus velutina)*, white

[2] The nomenclature throughout this paper is that of Gray's Manual, 7th edition.

elm *(Ulmus americana)* white ash *(Fraxinus americana)* and wild black cherry *(Prunus serotina)*. In some places this association is scarcely distinguishable from the next but in other cases, as in section 28, there are quite extensive and well marked areas of it.

The mixed hillside association (34, 34.1, 34.2 and 34.3). The forest that occupies the yellow silt loam on the slopes and in the ravines is transitional in its nature. It really consists of several distinct forest associations but the representations of the separate associations are often so limited in extent that each one includes only a few individual trees. For this reason it is thought best to treat it here as a mixed association and without any attempt to indicate any particular species as dominant, since different species are dominant in different parts of the forest. The species of trees in this forest vary from those of the mesoxerophytic association described above, such as black, white and chestnut oaks *(Quercus velutina, Q. alba* and *Q. prinus)* and the shagbark and pignut hickories *(Carya ovata* and *C. cordiformis)* and sometimes red cedar *(Juniperus virginiana)* on the higher parts of the slope, through the group of species characteristic of more mesophytic forests such as hard maple *(Acer saccharum)*, beach *(Fagus grandifolia)*, red, yellow and shingle oaks *(Quercus rubra, Q. imbricaria* and *Q. muhlenbergii)*, basswood *(Tilia americana)*, red elm *(Ulmus fulva)*, ironwood *(Ostrya. virginiana)*, red bud *(Cercis canadensis)* and white ash *(Fraxinus americana)* in the intermediate positions, to the species more characteristic of hydrophytic forests such as red ash *(Fraxinus pennsylvanica)*, American elm *(Ulmus americana)*, walnut *(Juglans nigra)*, sycamore *(Platanus occidentalis)*, honey locust *(Gleditsia triacanthos)* and sometimes black willow *(Salix nigra)* or occasionally glaucous willow *(Salix discolor)* on the lower parts of the slopes and in the bottoms of the valleys. This type of forest is more extensive than any other in this region, for the reason that the land on which it grows is mostly too steep or too hilly for cultivation. Certain patches of this type, too, are the only forests in the region that are not persistently pastured. No forests were found that had never been pastured, but certain areas of the mixed hillside association are apparently pastured only when the adjoining fields are pastured

and so they are given some opportunity for reproduction. None of the yellow silt loam soil should ever be cleared under any circumstances, for clearing allows erosion to set in and the result is apt to be disastrous. For instance, there is a field in section 5 which is rapidly being destroyed by having deep furrows and ravines cut into it by eroding floods. This could never have happened if the forest had not been removed.

The beech-maple-red oak association (35 and 35.2). This is a xerarch-mesophytic forest association, which means that it is a mesophytic forest which was developed from, or was preceded by, a more xerophytic forest. The dominant trees are either beech *(Fagus grandifolia)* and hard maple *(Acer saccharum)*, or hard maple and red oak *(Quercus rubra)* or sometimes all three of these species. This is the association that formerly covered all of the yellow gray silt loam soil and is the climax type of forest in this region but, as the map indicates, it has mostly disappeared and only a few small patches, some of which are very thin, remain. It is probable that these patches also will soon entirely disappear, since the soil occupied by them is all suitable for cultivation. In this particular region there is very little beech, but it is obvious that there was formerly much more and that its infrequency now is due to the fact that it has suffered more from cutting than has either maple or oak. The little patch of this association near the southeast corner of section 9 is an almost pure stand of hard maple, nearly all other trees having been cut out. In other cases, however, the dominant species are accompanied by greater or lesser numbers of the following: basswood *(Tilia americana)*, white elm *(Ulmus americana)*, white ash *(Fraxinus americana)*, wild black cherry *(Prunus serotina)*, black, white and shingle oaks *(Quercus velutina, Q. alba* and *Q. imbricaria)*, butternut *(Juglans cinerea)*, walnut *(Juglans nigra)*, Kentucky coffee tree *(Gymnocladus dioica)* and ironwood *(Ostrya virginiana)*.

The basswood-elm association (38 and 38.2). This is the hydrarch-mesophytic forest association, having developed from a more hydrophytic type, and formerly occupied all of the brown silt loam soil. Like the xerarch mesophytic forest it has nearly all disappeared and the few remnants probably will not be left much longer. The

dominant trees are the basswood *(Tilia americana)* and the white elm *(Ulmus americana)*. Along with these occur hard maple *(Acer saccharum)*, walnut *(Juglans nigra)*, yellow oak *(Quercus muhlenbergii)*, white and red ash *(Fraxinus americana* and *F. pennsylvanica)*, and hackberry *(Celtis occidentalis)*.

Hydrophytic Forest Associations.

The elm-sycamore-maple association (41, 41.1, 41.2 and 41.3). This is the hydrophytic forest that formerly occupied most of the mixed loam or bottomland soil. A great deal of this soil has been cleared but a number of representative bottomland forests still remain especially as narrow strips along the river. The dominant trees of this forest are the white elm *(Ulmus americana)*, the sycamore *(Platanus occidentalis)* and the soft maple *(Acer saccharinum)*. Along with these occur hackberry *(Celtis occidentalis)*, box elder *(Acer negundo)*, green ash *(Fraxinus pennsylvanica* var. *lanceolata)*, bur-oak *(Quercus macrocarpa)*, walnut *(Juglans nigra)* honey locust *(Gleditsia triacanthos)*, black maple *(Acer saccharum* var. *nigrum)* and cottonwood *(Populus deltoides)*.

The cottonwood-willow association (43). This hydrophytic association is represented in several places along the river. In most places it consists almost exclusively of cottonwood *(Populus deltoides)* and black willow *(Salix nigra)*, with the sandbar willow *(Salix longifolia)* occurring where the river is depositing sand. These sand deposits are frequently submerged and most plants are unable to grow on them at all, but the sandbar willow does not suffer from the water. It has to contend rather with biotic factors, since it is usually badly infested with willow-cone galls and often is completely covered with a species of dodder.

The cottonwood-willow slough association (51). This association is represented only by a small patch in the southern part of section 9. Here an old abandoned gravel-pit has as its center a patch of cattails *(Typha latifolia)* which is surrounded by an association of young trees and shrubs of the glaucous and black willows *(Salix discolor* and *S. nigra)*, cottonwood *(Populus deltoides)* and a few sycamores *(Platanus occidentalis)*.

STRIP LAND.

An S on the map indicates land that has been "stripped" by the coal mining companies. After "stripping" the land is left in such a condition that it cannot readily be used for agricultural purposes. It consists of alternate ridges and furrows, the ridges varying from three or four to twelve or fifteen feet in height. If simply left alone the "striplands" would become covered with bottomland forests in most cases in 25 or 30 years. The revegetation process could be greatly hastened of course by artificial planting, and it is probable that reforestation would be the most suitable economical means of reclaiming these lands.

TITLE:

GEOGRAPHIC SUBDIVISIONS OF CUMBERLAND COUNTY, ILLINOIS.

LEGEND.

1. Upland prairie of the western border of the county.
2. Inter-stream upland prairies.
3. Forest Area of the western creeks.
4. Forest area of the Embarrass and the eastern creeks.
5. Morainal outwash plains of the northern border.

NOTE: The east-west extent is 25 miles.

CONSTITUTION AND BY-LAWS

Illinois Academy of Science

CONSTITUTION

ARTICLE I. NAME

This Society shall be known as THE ILLINOIS STATE ACADEMY OF SCIENCE.

ARTICLE II. OBJECTS

The objects of the Academy shall be the promotion of scientific research, the diffusion of scientific knowledge and scientific spirit, and the unification of the scientific interests of the State.

ARTICLE III. MEMBERS

The membership of the Academy shall consist of *Active Members*, *Non-resident Members*, *and Life Members*.

Active Members shall be persons who are interested in scientific work and are residents of the State of Illinois. Each active member shall pay an initiation fee of one dollar and an annual assessment of one dollar.

Non-resident Members shall be persons who have been members of the Academy but have removed from the State. Their duties and privilges shall be the same as those of active members except that they may not hold office.

Life Members shall be active or non-resident members who have paid fees to the amount of twenty dollars. They shall be free from further annual dues.

For election to any class of membership the candidate's name must be proposed by two members, be approved by a majority of the committee on membership, and receive the assent of three-fourths of the members voting.

All workers in science present at the organization meeting who sign the constitution, upon payment of their initiation fee and their annual dues for 1908, become charter members.

ARTICLE IV. OFFICERS

The officers of the Academy shall consist of a President, a Vice-President, a Librarian, a Secretary, and a Treasurer. The chief of the Division of State Museum of the Department of Registration and Education of the state government shall be the Librarian of the Academy. All other officers shall be chosen by ballot on recommendation of a nominating committee, at an annual meeting, and shall hold office for one year or until their successors qualify.

They shall perform the duties usually pertaining to their respective offices.

It shall be one of the duties of the President to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

The Librarian shall have charge of all the books, collections, and material property belonging to the Academy.

Article V. Council

The Council shall consist of the President, Vice-President, Secretary, Treasurer, Librarian, and the president of the preceding year. To the Council shall be entrusted the management of the affairs of the Academy during the intervals between regular meetings.

The Board of State Museum Advisers, created under the provisions of the Civil Administrative Code of Illinois shall be consulted by the officers of the Academy in all matters which concern the general policy of the Academy in its relations to the Division of State Museum.

Article VI. Standing Committees

The Standing Committees of the Academy shall be a Committee on Publication and a Committee on Membership and such other committees as the Academy shall from time to time deem desirable.

The Committee on Publication shall consist of the President, the Librarian, and a third member chosen annually by the Academy.

The Committee on Membership shall consist of five members chosen annually by the Academy.

Article VII. Meetings

The regular meetings of the Academy shall be held at such time and place as the Council may designate. Special meetings may be called by the Council and shall be called upon written request of twenty members.

Article VIII. Publication

The regular publications of the Academy shall include the transactions of the Academy and such papers as are deemed suitable by the Committee on Publication.

All members shall receive gratis the current issues of the Academy.

Article IX. Affiliation

The Academy may enter into such relations of affiliation with other organizations of appropriate character as may be recommended by the Council and be ordered by a three-fourths vote of the members present at any regular meeting.

Article X. Amendments

This constitution may be amended by a three-fourths vote of the membership present at an annual meeting, provided that notice of the desired change has been sent by the Secretary to all members at least twenty days before such meeting.

BY-LAWS

I. The following shall be the regular order of business:

1. Call to order.
2. Reports of officers.
3. Reports of standing committees.
4. Election of members.
5. Reports of special committees.
6. Appointment of special committees.
7. Unfinished business.
8. New business.
9. Election of officers.
10. Program.

Adjournment.

II. No meeting of the Academy shall be held without thirty days' previous notice being sent by the Secretary to all members.

III. Fifteen members shall constitute a quorum of the Academy. A majority of the Council shall constitute a quorum of the Council.

IV. No bill against the Academy shall be paid without an order signed by the President and Secretary.

V. Members who shall allow their dues to remain unpaid for three years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

VI. The Librarian shall have charge of the distribution, sale, and exchange of the published transactions of the Academy, under such restrictions as may be imposed by the Council.

VII. The presiding officer shall at each annual meeting appoint a committee of three who shall examine and report in writing upon the account of the Treasurer.

VIII. No paper shall be entitled to a place on the program unless the manuscript or an abstract of the same shall have been previously delivered to the Secretary. Papers presented *in absentia*, shall be read by title only, unless the Academy votes to hear them.

IX. The Secretary and Treasurer shall have their expenses paid from the Treasury of the Academy while attending council meetings and annual meetings. Other members of th council may have their expenses paid while attending meetings of the council, other than those in connection with annual meetings.

X. These by-laws may be suspended by a three-fourths vote of the members present at any regular meeting.

List of Members

Life Members

(Revised December, 1919)

*Andrews, C. W., LL. D., The John Crerar Library, Chicago. (Sci. Bibliog.)
*Bain, Walter G., M. D., St. John's Hospital, Springfield. (Bacteriology.)
Barber, F. D., M. S., State Normal University, Normal. (Physics.)
Barnes, R. M., LL. D., Lacon. (Zoology.)
Barnes, William, M. D., Decatur. (Lepidoptera.)
*Bartow, Edward, Ph. D., State Water Survey, Urbana. (Chemistry.)
Chamberlain, C. J., Ph. D., University of Chicago, Chicago. (Botany.)
Chamberlin, T. C., LL. D., University of Chicago, Chicago. (Geology.)
*Cowles, H. C., Ph. D., University of Chicago, Chicago. (Botany.)
*Crew, Henry, Ph. D., Northwestern University, Evanston. (Physics.)
*Crook, A. R., Ph. D., State Museum, Springfield. (Geology.)
Davis, Mrs. Robert L., A. B. (Edna K. Rentchler), Dept. of Agriculture, Washington, D. C.
Deal, Don W., M. D., Leland Office Building, Springfield. (Medicine.)
*Farrington, O. C., Ph. D., Field Museum, Chicago. (Mineralogy.)
Ferriss, J. H., Joliet. (Botany.)
*Forbes, S. A., Ph. D., LL. D., University of Illinois, Urbana. (Zoology.)
Fuller, Geo. D., Ph. D., University of Chicago, Chicago. (Botany.)
*Gates, Frank C., Ph. D., State Agricultural College, Manhattan, Kans.
Hagler, E. E., M. D., Capitol and Fourth Sts., Springfield. (Oculist.)
Hankinson, T. L., A. M., N. Y. College of Forestry, Syracuse, N. Y. (Zoology.)
*Hessler, J. C., Ph. D., James Millikin University, Decatur. (Chemistry.)
Hinkley, A. A., Dubois. (Conchology.)
Hoskins, William, 111 W. Monroe St., Chicago. (Chemistry.)
Hunt, Robert I., Decatur. (Soils.)
Jordan, Edwin O., Ph. D., University of Chicago, Chicago. (Bacteriology.)
Kunz, Jacob, Ph. D., University of Illinois, Urbana. (Physics.)
Latham, Vida A., M. D., D. D. S., 1644 Morse Ave., Chicago. (Microscopy.)
Lillie, F. R., Ph. D., University of Chicago, Chicago. (Zoology.)
Marshall, Ruth, Ph. D., Lane Technical High School, Chicago. (Zoology.)
Miller, G. A., Ph. D., University of Illinois, Urbana. (Mathematics.)
Moffatt, Mrs. Lizzie M., Wheaton.
Moffatt, Will S., 105 S. LaSalle St., Chicago. (Botany.)
*Noyes, W. A., Ph. D., University of Illinois, Urbana. (Chemistry.)
*Oglevee, C. S., Sc. D., Lincoln College, Lincoln. (Biology.)
Payne, Edward W., State National Bank, Springfield. (Archaeology.)
*Pepoon, H. S., M. D., Lake View High School, Chicago. (Botany.)
Pricer, J. L., A. M., State Normal University, Normal. (Botany.)
Smith, Frank, A. M., University of Illinois, Urbana. (Zoology.)
*Smith, Isabel Seymour, M. S., Illinois College, Jacksonville. (Botany.)
*Smith, L. H., University of Illinois, Urbana. (Plant Breeding.)
Stevenson, A. L., Lincoln School, 1808 Morse Ave., Chicago.
Stillhamer, A. G., Bloomington. (Physics.)
Sykes, Mabel, B. S., South Chicago High School, Chicago. (Geology.)
Trelease, William, LL. D., University of Illinois, Urbana. (Botany.)
Ward, Henry B., Ph. D., University of Illinois, Urbana. (Zoology.)
Washburn, E. W., Ph. D., University of Illinois, Urbana. (Chemistry.)
Weller, Annie, L., State Normal School, Charleston.

*Charter members.

Weller, Stuart, Ph. D., University of Chicago, Chicago. (Paleontology.)
Zeleny, Charles, Ph. D., University of Illinois, Urbana. (Zoology.)

ACTIVE MEMBERS

Adams, Wm. J., A. M., 238 Holton St., Galesburg. (Biological Science.)
Ashman, George C., Ph. D., Bradley Institute, Peoria. (Chemistry.)
Alexander, Alida, B. S., 231 W. College Ave., Jacksonville. (Biology.)
Andras, J. C., Manchester. (Biology.)
*Atwell, Chas. B., Ph. M., Northwestern University, Evanston. (Botany.)
Baird, Grace J., A. B., 5605 Dorchester Ave., Chicago. (Biology.)
Baker, Frank C., Ph. D., University of Illinois, Urbana. (Conchology.)
Baker, W. J., Galesburg. (Chemistry.)
Ball, John R., A. M., 820 Hamilton St., Evanston. (Geology.)
Barwell, John William, Waukegan. (Anthropology.)
Baumeister, George F., B. S., Aledo. (Biology and Chemistry.)
Bayley, W. S., Ph. D., University of Illinois, Urbana. (Geology.)
Beal, James Hartley, Sc.D., 801 W. Nevada St., Urbana. (Pharmaceutical Research.)
Bensley, Robert R., M. D., University of Chicago, Chicago. (Anatomy.)
Bergner, E. A., M. S., 315 S. Church St., Jacksonville. (Physics.)
Blake, Anna M., S. B., 203 N. School St., Normal. (Botany and Physiology.)
Blount, Ralph E., 124 S. Oak Park Ave., Oak Park. (Geography.)
Bonnell, Clarence, Township High School, Harrisburg. (Biology.)
Burge, William E., Ph. D., University of Illinois, Urbana. (Physiology.)
Butcher, B. H., A. B., Canton. (Science Education.)
Braun, E. J., B. E., Normal. (Biology.)
Cann, Jessie Y., Ph.D., 602 S. Lincoln Ave., Urbana. (Chemistry.)
Carey, J. P., B. S., Charleston. (Geog. and Geol.)
Carlston, A. J., Ph. D., University of Chicago, Chicago. (Physiology.)
*Carpenter, Chas. K., D. D., 311 Park St., Elgin. (Ornithology.)
Cederberg, Wm. E., Ph.D., Augustana College, Rock Island. Mathematics.)
Chamberlin, Rollin T., Hyde Park Hotel, Chicago. (Geology.)
Child, C. M., Ph. D., University of Chicago, Chicago. (Zoology.)
Clark, H. Walton, A. M., U. S. Biological Station, Fairport, Iowa. (Botany and Zoology.)
Clute, W. N. Joliet. (Botany.)
Coffin, Fletcher B., Ph. D., Lake Forest. (Physical Chemistry.)
Compton, James S., Eureka College, Eureka. (Biology.)
Cook, Nettie M., 405 W. Monroe St., Springfield. (Botany.)
*Coulter, John G., Ph. D., Chicago. (Botany.)
Covington, E. Gray, M. D., 410 E. Market St., Bloomington. (Medicine.)
*Coulter, John M., Ph. D., University of Chicago, Chicago. (Botany.)
*Crandall, Chas. S., M. S., University of Illinois, Urbana. (Botany.)
Crocker, William, Ph. D., University of Chicago, Chicago. (Botany.)
Crowe, A. B., A. M., Eastern State Normal School, Charleston. (Physics.)
Daniels, F. B., Pullman Building, Chicago.
Davis, N. S., M. D., 470 W. California St., Pasadena, Calif. (Medicine.)
Davis, Roy E., B. A., Aurora High School, Aurora. (Physiology.)
DeWolf, F. W., B. S., Illinois Geological Survey, Urbana. (Geology.)
Downing, Elliott R., Ph. D., University of Chicago, Chicago. (Zoology.)
Dufford, R. J., 1117 Ayars Place, Evanston. (Physics.)
Ekblaw, W. E., Ph. D., University of Illinois, Urbana. (Geology.)

*Charter members.

Eldredge, Anthony G., Physics Building, University of Illinois, Urbana. (Photography.)
Englis, Duane T., Ph. D., Chemistry Building, U. of I. (Chemistry.)
Eyeman, R. L., B. S., Jerseyville. (Agriculture.)
Faust, Ernest Carroll, Ph. D., 333 Nat. Hist. Building, Urbana. (Zoology.)
Finley, J. Orton, Oneida. (Agriculture.)
*Fisher, Fannie, Assistant Curator, State Museum, Springfield. (General Interest.)
Flint, W. P., Assistant State Entomologist, 1006 S. Orchard St., Urbana. (Entomology.)
Foberg, J. Albert, B. S., 4031 N. Avers Ave., Chicago. (Mathematics.)
Folsom, Justus W., Sc. D., University of, Illinois Urbana. (Entomology.)
Frank, O. D., 1464 Vermont St., Quincy. (Botany.)
Frison, T. H., University of Illinois. (Entomology.)
Gantz, R. A., A. B., 411 N. Talley St., Muncie, Ind. (Botany.)
Gault, B. T., 2313 Washington Blvd., Chicago. (Ornithology.)
Gerhard, William J., Field Museum, Chicago.
Geussenhainer, Lilah, A. M., State Normal University, Normal. (Home Economics.)
Glasgow, R. D., Ph. D., University of Illinois, Urbana. (Entomology.)
Glenn, P. A., A. M., 506½ W. High St., Urbana.
Goode, J. Paul, Ph. D., 6227 Kimbark Ave., Chicago. (Geography.)
Grant, U. S., Ph. D., Northwestern University, Evanston. (Geology.)
Griffith, H. E., A. M., Knox College, Galesburg. (Chemistry.)
Gurley, Wm. F. E., 6151 Lexington Ave., Chicago. (Paleontology.)
Haas, William H., A. M., Northwestern University, Evanston. (Geography.)
Hansen, Paul, State Department of Public Health, Springfield. (Sanitation.)
Harding, H. A., Ph. D., University of Illinois, Urbana. (Bacteriology.)
Harkins, William D., Ph. D., 5437 Ellis Ave., Chicago. (Chemistry.)
Harmon, C. F., M. D., 318½ S. Sixth St., Springfield. (Medicine.)
Harriman, E. H., A. M., High School, Springfield. (Chemistry and Physics.)
Harris, Charles L., Macomb. (Archaeology.)
Hartin, Fred, B. E., Price, Utah. (Biology.)
Haupt, Arthur W., Carthage College, Carthage. (Botany.)
Hemenway, Henry B., A. M., M. D., 217 Blackman Place, Springfield. (Public Health.)
Henderson, William F., B. A., 1345 W. Forest Ave., Decatur. (Biology.)
Hubbs, Carl L., A. M., Museum of Zoology, Ann Arbor, Mich. (Zoology.)
Hildebrand, L. E., A. M., 808 Hamlin St., Evanston. (Zoology.)
*Hill, W. K., Carthage College, Carthage. (Biology.)
Hinchliff, Grace, 419 College Ave., DeKalb.
Hines, Murray A., Ph. D., 1704 Hinman Ave., Evanston. (Chemistry.)
Hitch, C. Bruce, B. E., Township High School, Eureka. (Botany.)
Hoffman, Leslie R., 213 Baker Ave., Joliet. (Entomology.)
Holgate, T. F., LL. D., 617 Library St., Evanston. (Mathematics.)
Hottes, C. F., Ph. D., University of Illinois, Urbana. (Botany.)
House, Edward O., Ph. D., 317 S. 8th St., Monmouth. (Chemistry.)
Husted, Ward W., B. S., 256 S. Cedar St., Galesburg. (Chemistry.)
Hyde, L. H., Ph. D., 502 S. Eastern Ave., Joliet. (Geology.)
Illinois State Library, State House, Springfield.
Jamison, A. W., M. S., Agricultural Extension, University of Illinois, Urbana. (Physics.)
Jelliff, Fred R., A. B., Galesburg. (Geology.)
Johnson, Frank Seward, M. D., 2521 Prairie Ave., Chicago.

Johnson, Geo. F., 625 Black Ave., Springfield. (Astronomy.)
Jones, Jas. H., B. S., 2106 Maple Ave., Evanston. (Biology.)
Kempton, F. E., M. S., Botany Annex, Urbana. (Plant Pathology.)
Kingsley, J. S., D. Sc., 1011 W. California Ave., Urbana. (Zoology.)
Kinnear, T. J., M. D., Ridgely Bank Building, Springfield. (Medicine.)
Kisler, L. P., Roanoke.
*Knipp, Chas. T., Ph. D., University of Illinois, Urbana. (Physics.)
Kreider, G. M., M. D., 522 Capitol Ave., Springfield. (Surgery.)
Krummel, Grace, East St. Louis High School, East St. Louis. (Physics.)
Kuh, Sidney, M. D., 31 N. State St., Chicago. (Medicine.)
Land, W. J. G., Ph. D., University of Chicago, Chicago. (Botany.)
Langford, Geo., B. S., Joliet. (Paleontology.)
Lanphier, Robert C., Ph. B., Sangamon Electric Co., Springfield. (Electricity.)
Larson, Karl, A. B., Augustana College, Rock Island. (Chemistry.)
Lambert, Earl L., B. S., Carthage. (Botany and Zoology.)
Lightbody, Ernest R., B. E., Weldon. (Biology.)
Lindsey, Clara, High School, White Hall. (Biology.)
Linder, O. A., 208 N. Fifth Ave., Chicago. (Editor "*Svenska-Amerikanaren.*")
Linkins, R. H., A. M., 206 N. Main St., Normal. (Zoology.)
Longden, A. C., Ph. D., Galesburg. (Physics.)
Lutes, Neil, 168 Wilson Ave., Dubuque, Ia. (Chemistry.)
Lyon, Thomas E., LL. B., Hay Building, Springfield. (Lawyer.)
MacFarland, D. F., Ph. D., University of Illinois, Urbana. (Chemistry.)
MasGillivray, A. D., Ph. D., University of Illinois, Urbana. (Entomology.)
MacInnes, F. Jean, B. S., 614 Michigan Ave., Urbana. (Plant Pathology.)
McAuley, Faith, High School, St. Charles. (Botany.)
McCauley, Geo. V., Northwestern University, Evanston. (Physics.)
McCoy, Herbert N., Ph. D., 6030 Kenwood Ave., Chicago. (Chemistry.)
McDougall, W. B., Ph. D., University of Illinois, Urbana. (Botany.)
McMillan, Mary Ann, A. B., Carthage. (Botany.)
McNallys, John L., 313 E. John St., Champaign.
McNutt, Wade, Township High School, Highland Park. (Botany.)
Marks, Sarah, A. B., Pecatonica. (Biology.)
Mathews, Albert P., Ph. D., University of Chicago, Chicago. (Physiological Chemistry.)
Mecham, John B., Ph. B., 118 S. Center St., Joliet.
Merry, Jessie B., S. B., 126 E. Fifth St., St. Charles. (Biology.)
Metzner, Albertine E., M. S., 326 S. Church St., Jacksonville. (Physics.)
Michelson, A. A., LL. D., University of Chicago, Chicago. (Physics.)
Millikan, R. A., Sc. D., 5605 Woodlawn Ave., Chicago. (Physics.)
Millspaugh, Chas. F., M. D., Field Museum, Chicago. (Botany.)
Miller, Marion, A. B., 760 W. North St., Jacksonville. (Biology.)
Montgomery, Chas. E., A. B., DeKalb. (Botany.)
Moulton, F. R., Ph. D., University of Chicago, Chicago. (Astronomy.)
Mumford, H. W., B. S., University of Illinois. (Animal Husbandry.)
Neiberger, William E., M. D., Bloomington. (Eugenics.)
Neifert, Ira E., M. S., 806 E. Knox St., Galesburg. (Chemistry.)
Neill, Alma J., A. M., 401 S. Wright St., Champaign. (Physiology.)
Nelson, C. Z., 534 Hawkingor Ave., Galesburg. (Botany.)
Newman, H. H., University of Chicago, Chicago. (Zoology.)
Nichols, H. W., B. S., Field Museum, Chicago. (Geology.)
North, E. M., B. A., Galesburg. (Geology, Astronomy and Pedagogy.)
Packard, W. H., Ph. D., Bradley Institute, Peoria. (Biology.)
Palmer, Geo. Thos., M. D., Prince Sanitarium, Springfield. (Medicine.)
Parker, Bertha M., S. B., 5707 Kimbark Ave., Chicago. (Gen. Sci. and Botany.)

*Parr, S. W., M. S., University of Illinois, Urbana. (Chemistry.)
Patterson, Alice J., Illinois State Normal University, Normal. (Entomology and Nature Study.)
Phipps, Charles Frank, M. S., State Normal School, DeKalb. (Physics and Chemistry.)
Ray, Ward L., A. M., Aledo. (Chemistry.)
Rathbone, W. V., Harrisburg. (Ornithology.)
Reiffel, M. I., 3510 Irving Park Blvd., Chicago. (Botany.)
Rice, William F., A. M., Wheaton College, Wheaton. (Physics.)
Richardson, R. E., Ph. D., Havana. (Zoology.)
Ricker, N. C., D. Arch., University of Illinois, Urbana. (Architecture.)
Ridgley, D. C., State Normal University, Normal. (Geography.)
Ridgway, Robert, M. S., 1030 S. Morgan St., Route 7, Olney. (Ornithology.)
Risley, W. J., A. M., James Millikin University, Decatur. (Mathematics.)
Robb, Mary E., University of Chicago, Chicago. (Geography.)
Robinson, C. H., Normal. (Archaeology.)
Root, Clarence J., U. S. Weather Bureau, Springfield. (Climatology.)
Rost, Louis N., Macomb. (Archaeology.)
Salisbury, R. D., LL. D., University of Chicago, Chicago. (Geology.)
Savage, T. E., Ph. D., University of Illinois, Urbana. (Stratigraphic Geology.)
Sayers, Frank E., B. S., M. D., Fisher. (Public Health.)
Schulz, W. F., Ph. D., 926 W. Green St., Urbana. (Physics.)
Shamel, C. H., Ph. D., 535 Black Ave., Springfield. (Chemistry.)
Shaw, L. I., Ph. D., University Club, Evanston. (Chemistry.)
Shelford, V. E., Ph. D., University of Illinois, Urbana. (Zoology.)
*Simpson, Q. I., Palmer. (Eugenics.)
Slocum, A. W., University of Chicago, Chicago.
Smallwood, Mabel E., 550 Surf St., Chicago. (Zoology.)
Smith, Eleanor C., B. S., 104 Winston Ave., Joliet.
*Smith, C. H., M.E., 5517 Cornell Ave., Chicago. (Editor *School Science*.)
Smith, Jesse L., Supt. of Schools, Highland Park.
Smith, Kieth K., Ph. D., Northwestern University, Evanston.
Smith, Sylvia, B. E., Evanston. (Biology.)
Soyer, Bessie, F. S., 315 S. Church St., Jacksonville. (Biology.)
Sperry, Holland R., Galesburg. (Biology.)
Spicer, C. E. Joliet. (Chemistry.)
Stark, Mabel C., Ph. B., University of Chicago, Chicago. (Earth Science.)
Stevens, F. L., Ph. D., University of Illinois, Urbana. (Plant Pathology.)
Stevens, W. A., B. A., Lockport. (Chemistry.)
*Strode, W. S., M. D., Lewiston. (Medicine.)
Strong, Harriet, B. S., Wheaton. (Biology.)
Tyler, A. A., Ph. D., James Millikin University, Decatur. (Biology.)
Tiffany, Hanford, Ohio State University, Columbus, O. (Botany.)
*Townsend, E. J., Ph. D., University of Illinois, Urbana. (Mathematics.)
Townsley, Fred D., A. B., James Millikin University, Decatur.
Trapp, A. R., M. D., Ill. Nat'l Bank Building, Springfield. (Medical Diagnosis.)
Turton, Chas. M., A. M., 2059 E. 72nd St., Chicago. (Physics.)
Udden, Anton D., 29 Snell Hall, University of Chicago, Chicago. (Physics and Mathematics.)
Van Cleave, H. J., Ph. D., University of Illinois. (Zoology.)
Vestal, A. G., Ph. D., Eastern State Normal School, Charleston. (Ecology.)
Wade, Esther, B. S., 421 W. Grove Ave., Oak Park. (Botany.)
Wager, R. E., A. M., Northern State Normal School, DeKalb. (Biology.)

Waggoner, H. D., Ph. D., 224 Ward St., Macomb. (Biology.)
Walsh, John, 282 W. Berrien St., Galesburg. (Water Supply.)
Warrum, Jesse J., A. B., Macomb. (Chemistry.)
Waterman, Warren G., Ph. D., Northwestern University, Evanston. (Botany.)
Weaver, Holla E., 714 Lincoln Ave., Charleston. (Biology.)
Weckel, Ada L., M. S., Twp. High School, Oak Park. (Zoology.)
Wells, C. C., Ph. D., 1006 S. Michigan Ave., Chicago. (Chemistry.)
Wescott, O. S., Waller High School, Chicago.
Whitten, J. H., Ph. D., 7111 Normal Ave., Chicago. (Botany.)
Wells, M. M., Ph. D., University of Chicago, Chicago. (Zoology.)
Wilczynscki, E. J., Ph. D., University of Chicago, Chicago. (Mathematics.)
Willard, Alice, M. A., 704 N. Cherry St. Galesburg.
Wilson, Eva M., M. D., Manhattan. (Medicine.)
Windsor, Mrs. P. L., 609 Michigan Ave., Urbana. (Entomology.)
Winslow, Charles A., 2125 Sherman Ave., Evanston. (Geology.)
Winter, S. A., A. M., Lombard College, Galesburg.
Wirdlinger, Sidney, Ph. D., Galesburg. (Chemistry.)
Wirick, C. M., A. M., Crane Technical High School, Chicago. (Chemistry.)
Woods, F. C., Galesburg. (Physics.)
Woodburn, William L., Northwestern University, Evanston. (Botany.)
Woodruff, Frank M., Chicago Academy of Science, Chicago. (Taxidermy.)
Zehren, Karl C., Flanagan. (Agriculture.)

CORRESPONDING MEMBERS

Abbott, J. F., Ph. D., Washington University, St. Louis, Mo. (Zoology.)
Coulter, S. M., Ph. D., Purdue University, Lafayette, Ind. (Botany.)
Eycleshimer, A. C., Ph. D., University of Illinois Medical College, Chicago. (Anatomy.)
Lyon, E. P., Ph. D., University of Minnesota, Minneapolis. (Physiology.)
Turner, C. H., Sumner High School, St. Louis, Mo. (Zoology.)
Widman, O., Ph. D., 5105 Morgan St., St. Louis, Mo. (Ornithology.)

NON-RESIDENT MEMBERS

Bagley, W. C., Ph. D., Teachers College, Columbia University, New York. (Educational Psychology.)
*Betten, Cornelius, Ph. D., Cornell University, Ithaca, N. Y. (Biology.)
Bleininger, A. V., U. S. Geological Survey, Pittsburgh, Pa. (Ceramics.)
*Clawson, A. B., A. B.,Dept. of Agriculture, Washington, D. C. (Biology.)
Daniels, L. E., Rolling Prairie, Ind., R. R. No. 2. (Conchology.)
*Davis, J. J., B. S., Entomological Laboratory, Riverton, N. J. (Entomology.)
DuBois, Henry M., A. M., LeGrand, Oregon. (Geology.)
*Ewing, H. E., Ph. D., State College, Ames, Iowa. (Zoology.)
Finley, C. W., A. M., Lincoln School of Teachers College, New York. (Zoology.)
Greene, Bessie, A. M., University of Colorado, Boulder, Colo. (Zoology.)
Greenman, J. M., Ph. D., Missouri Botanical Garden, St. Louis, Mo. (Botany.)
Groves, J. F., Ph. D., University of Wyoming, Laramie, Wyo. (Botany.)
Guberlet, J. E., Ph. D., Oklahoma A. E. M. College, Stillwater, Okla. tation.)
*Hutton, J. Gladden, M. S., State College, Brookings, S. Dak. (Geology.)
MacInnes, D. A., Ph. D., Massachusetts Institute of Technology, Cambridge, Mass. (Chemistry.)
Mohlman, F. W., 548 Orange St., New Haven, Conn. (Chemistry.)

Riddle, Oscar, Ph. D., Cold Spring Harbor, Long Island, New York.
Roberts, H. L., State Normal School, Cape Girardeau, Mo. (Geography.)
Ross, Clarence S., A. M., U. S. Geological Survey, Washington, D. C. (Geology.)
Sampson, H. C., Ph. D., Ohio State University, Columbus, Ohio.
Van Tuyl, Francis M., Ph. D., Colorado School of Mines, Boulder, Colo. (Geology.)
Weber, H. C. P., Ph. D., Westinghouse Electric Co., Pittsubrgh, Pa. (Chemistry.)
*Zetek, James, A. M., Box 245, Ancon, Panama Canal Zone. (Entomology.)

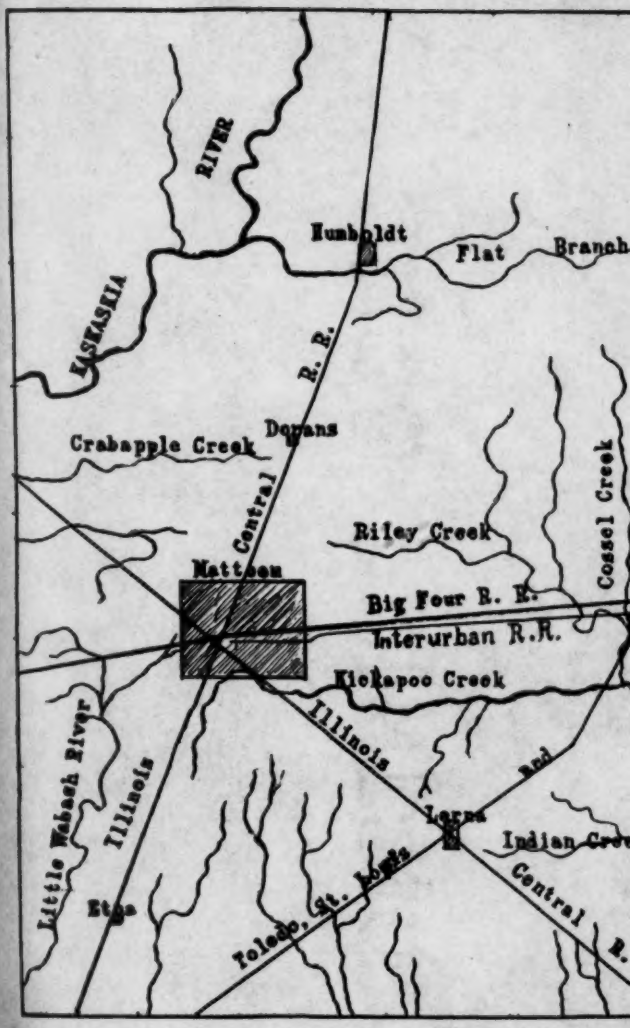
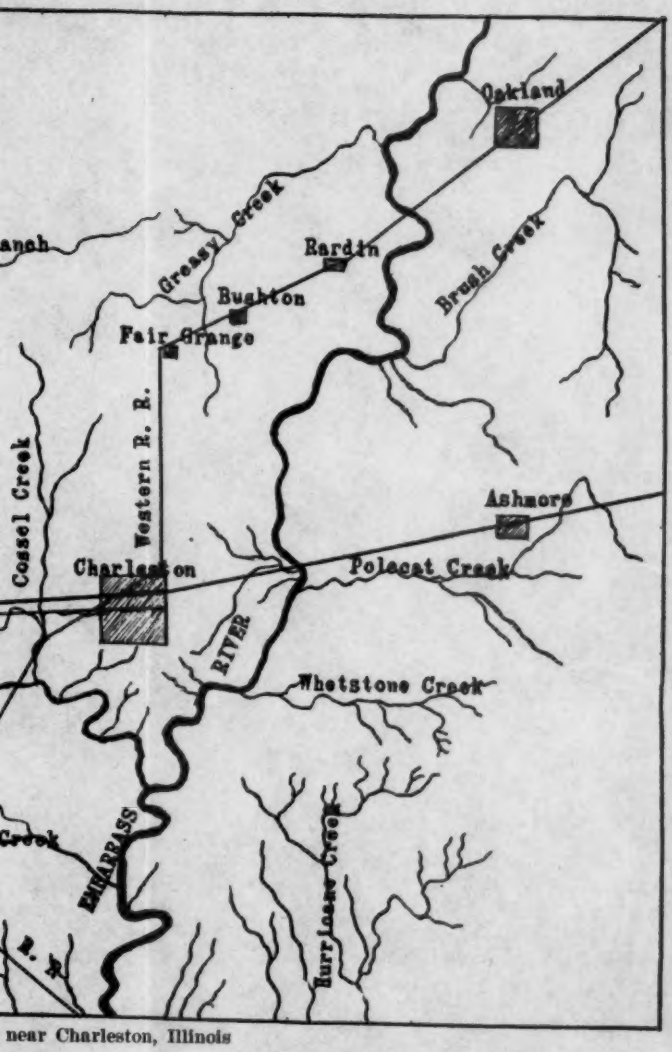
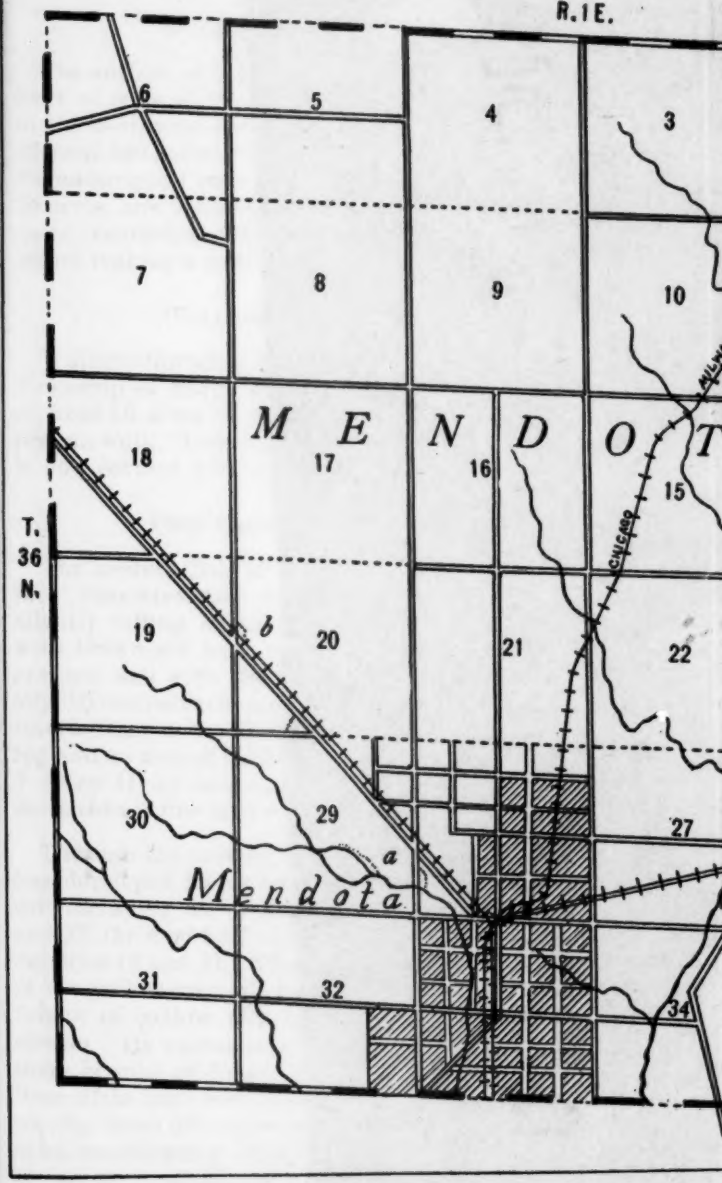


Fig. 1. Streams nea



near Charleston, Illinois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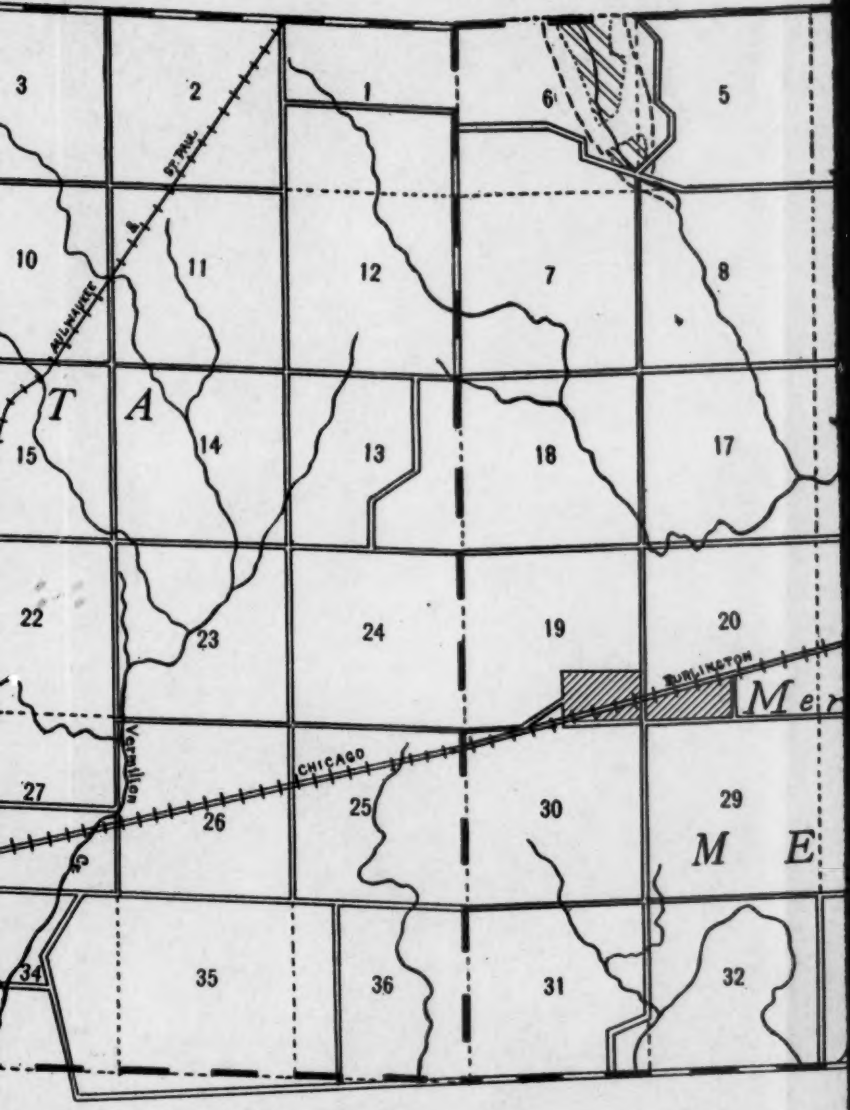
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CHICAGO
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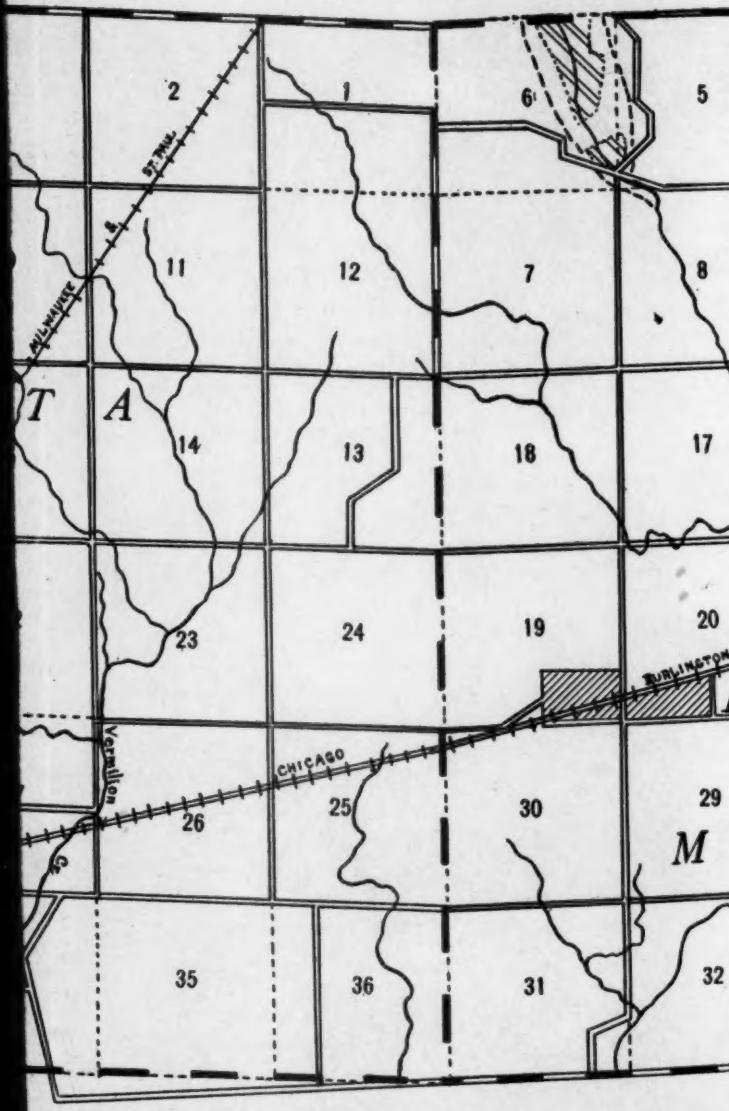
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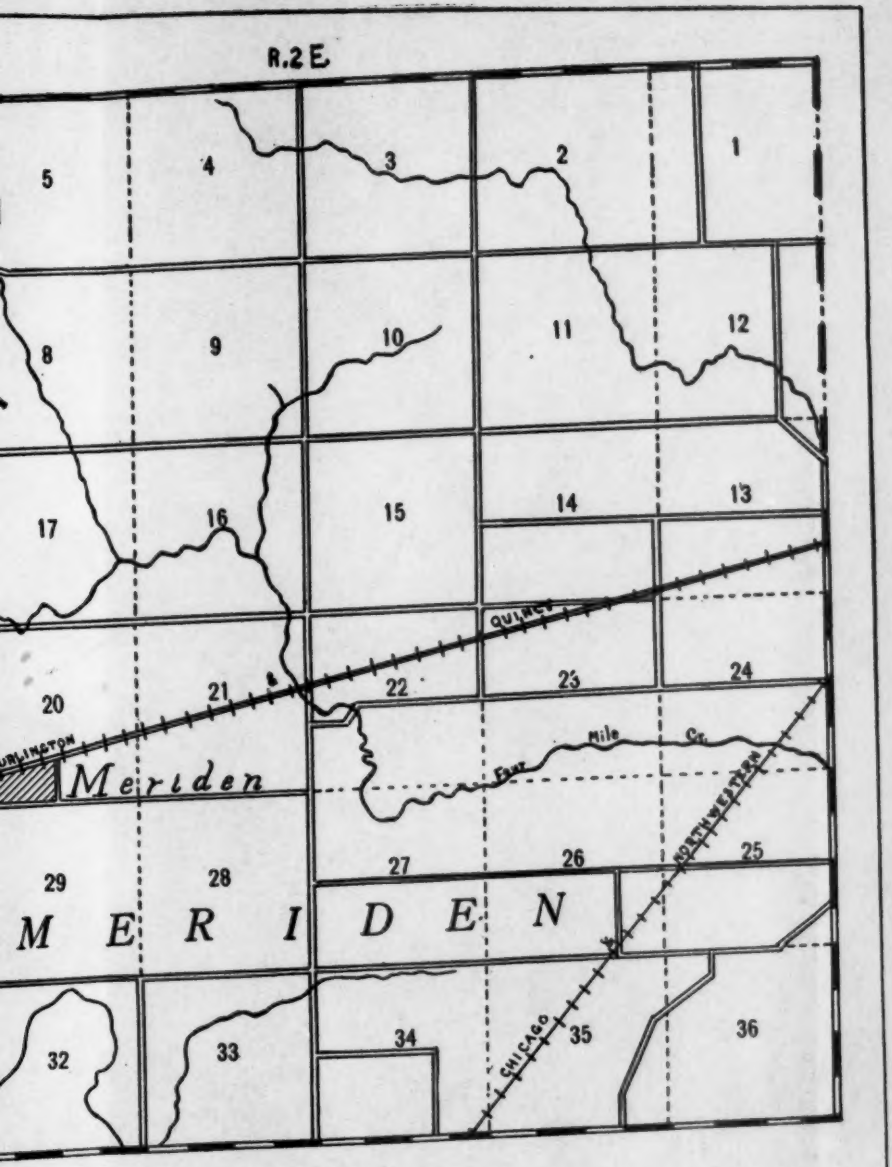
BURLINGTON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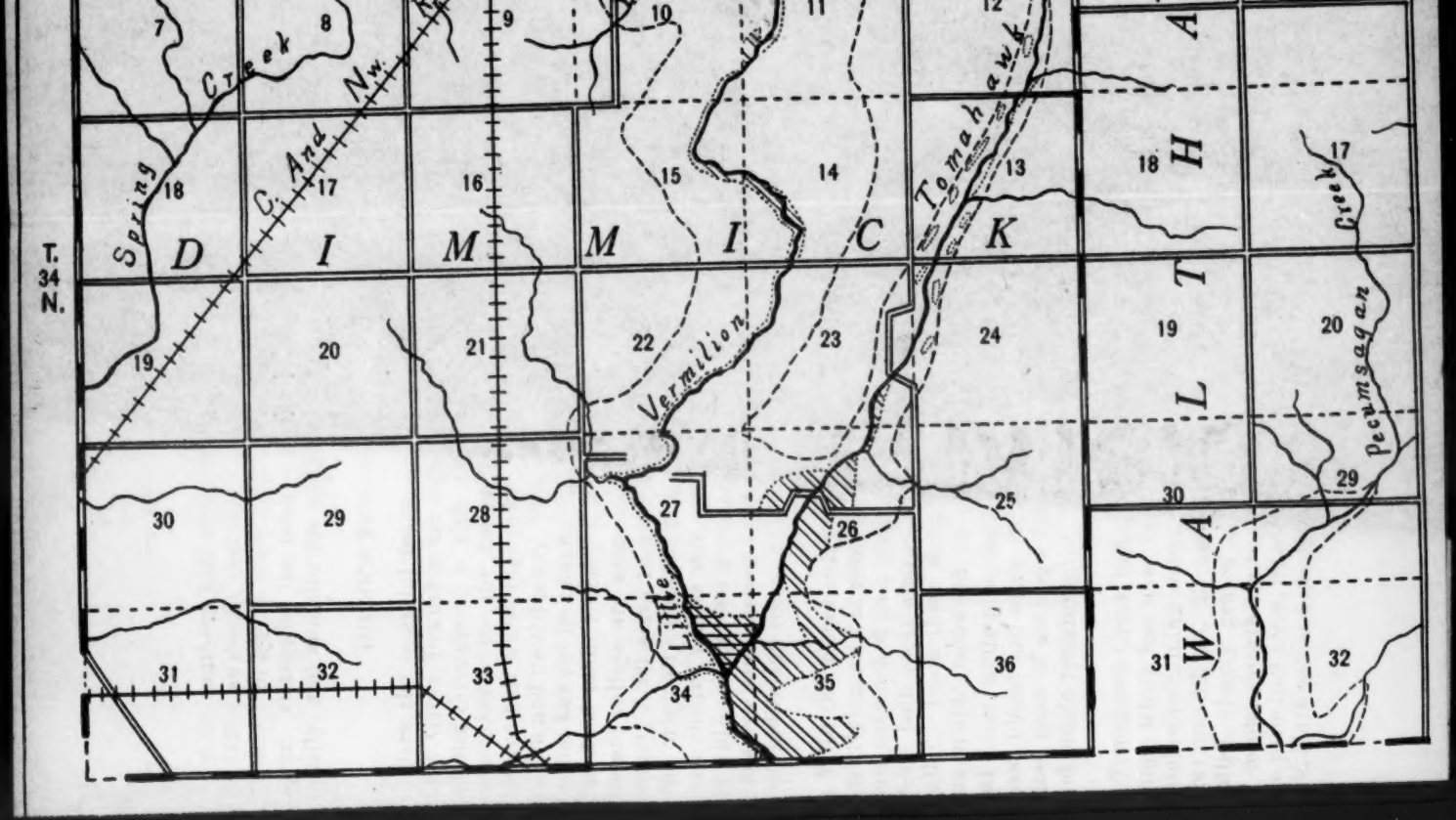
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Spring Creek
C. And Nw.
Tomahawk
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Vermilion
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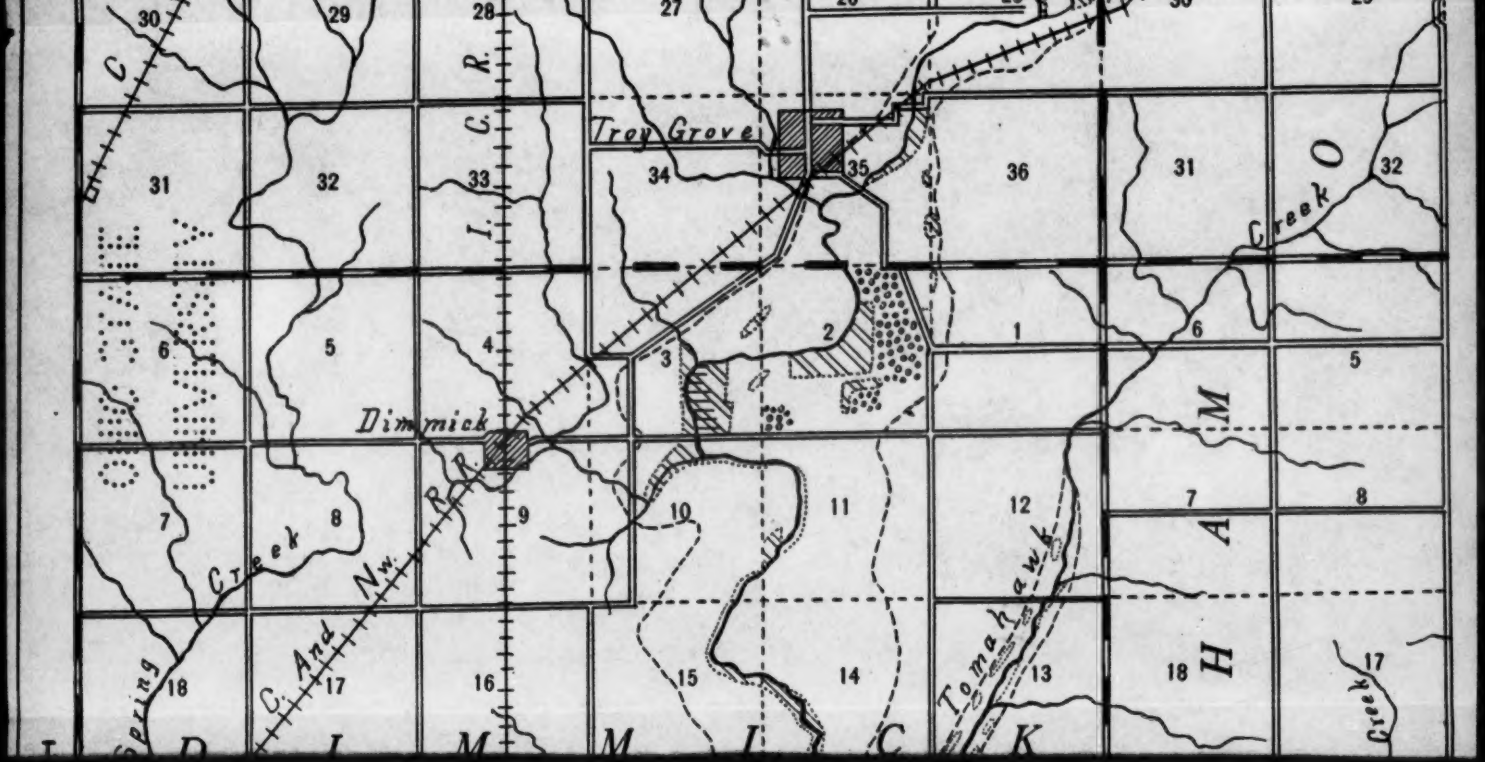
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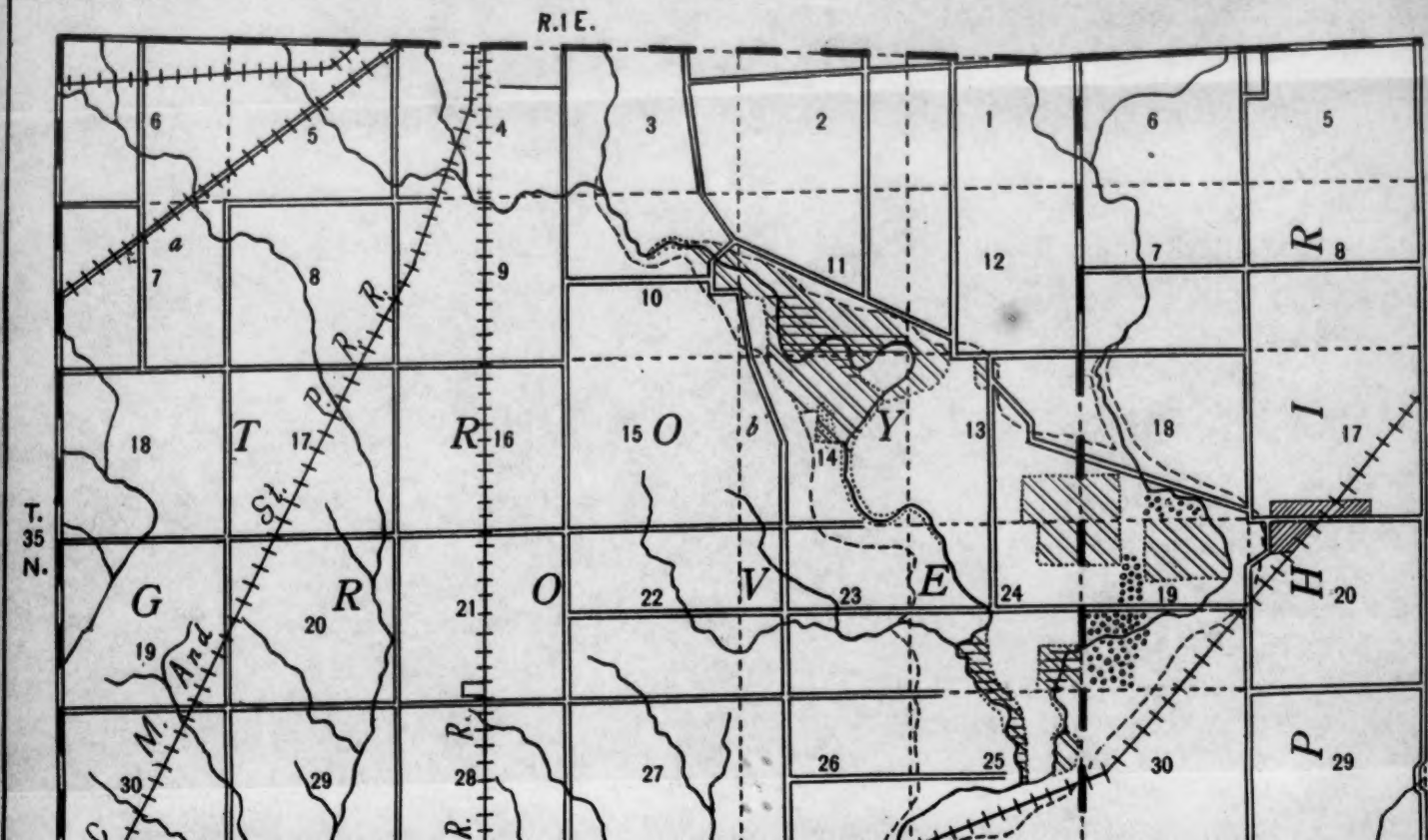
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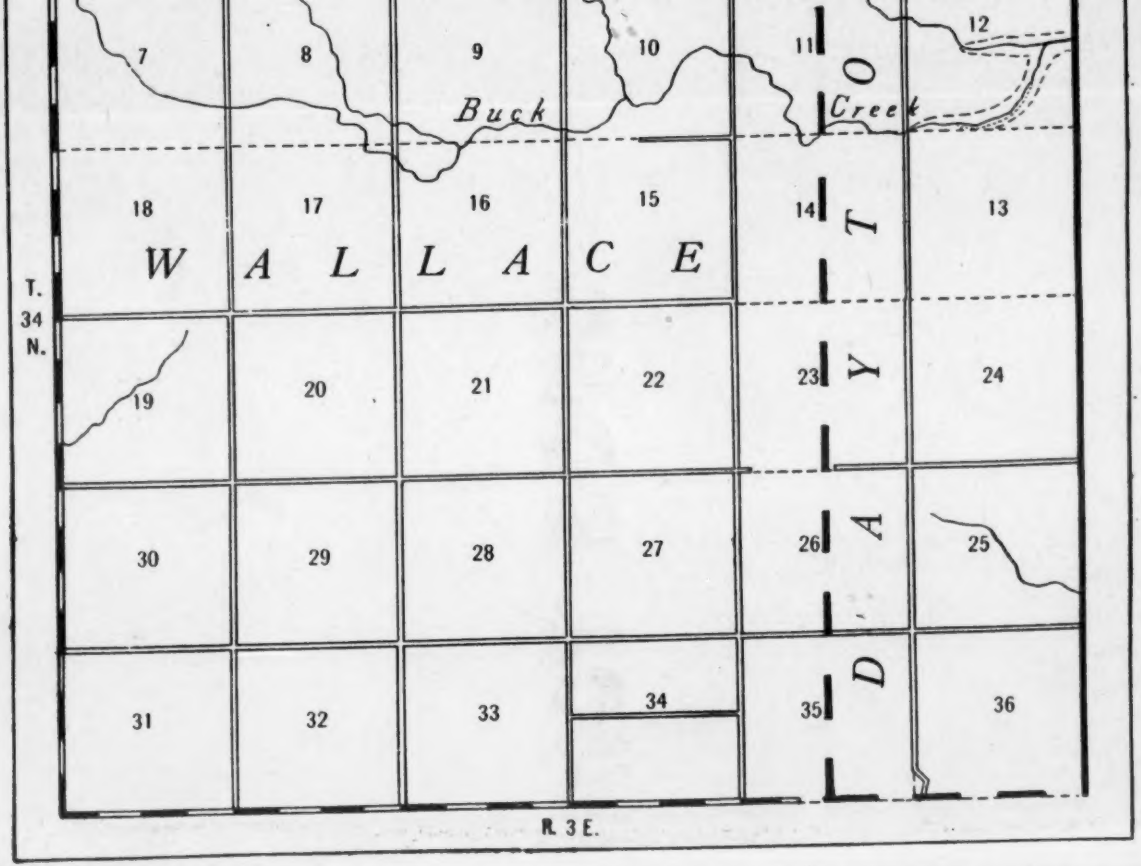
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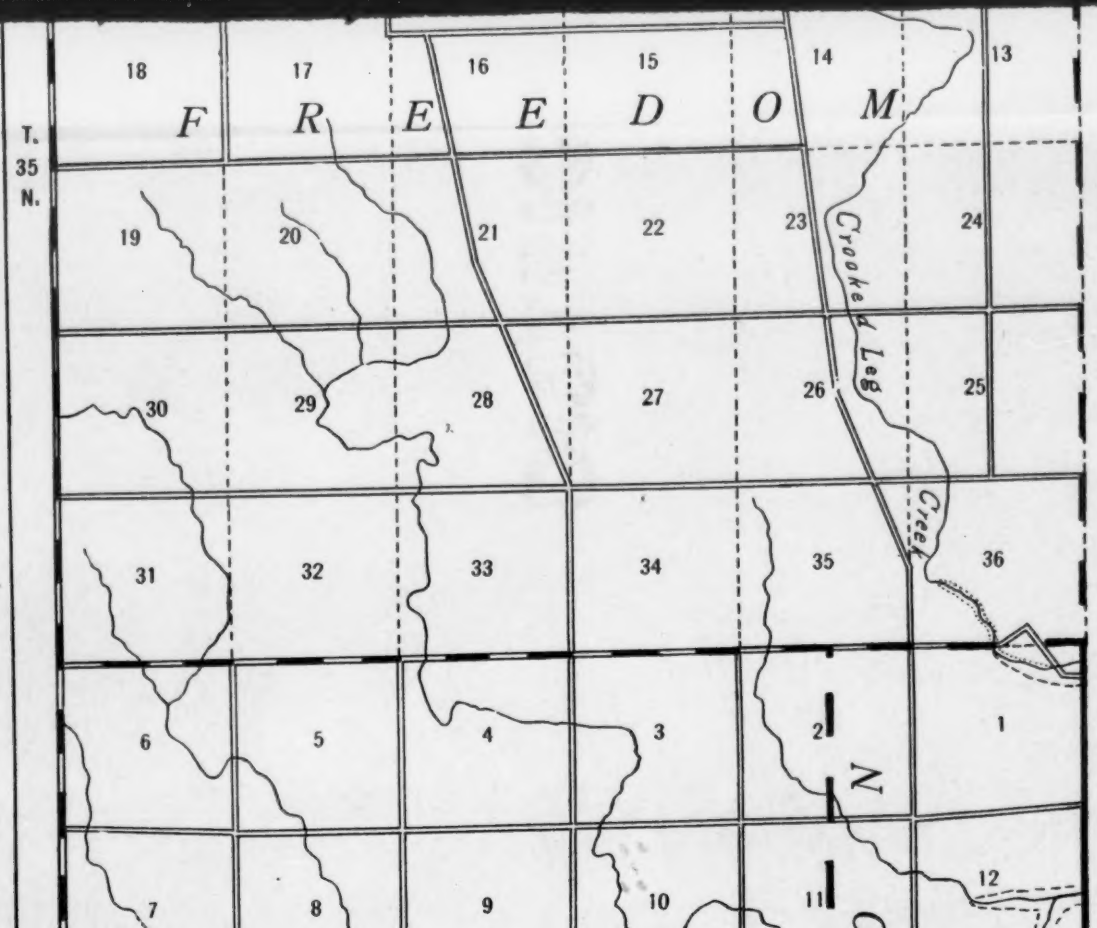
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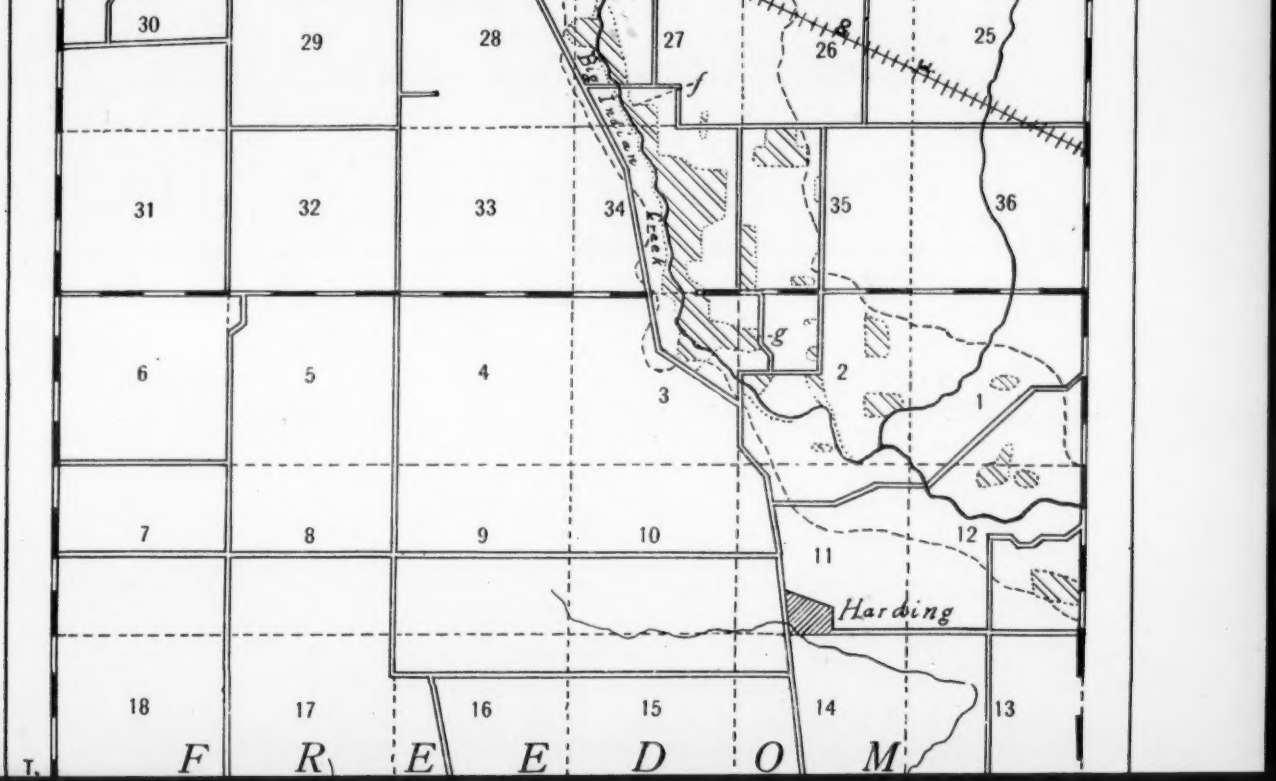
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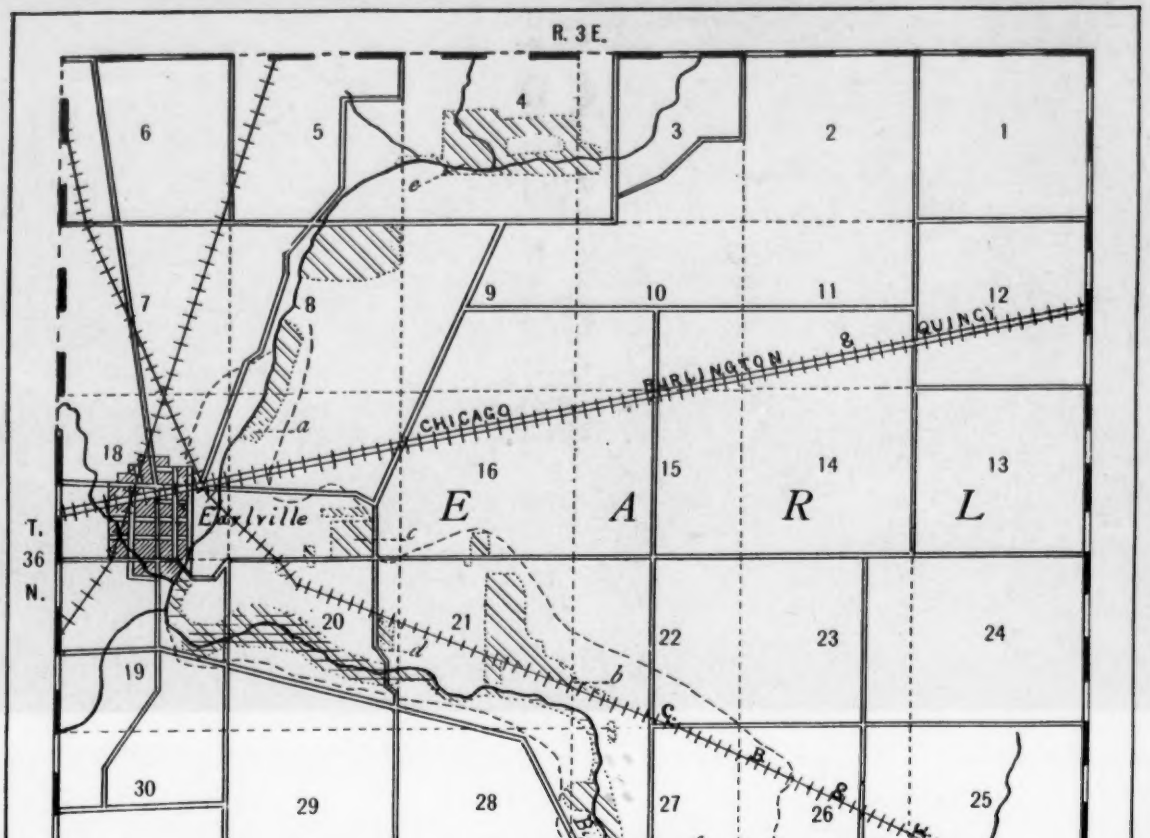
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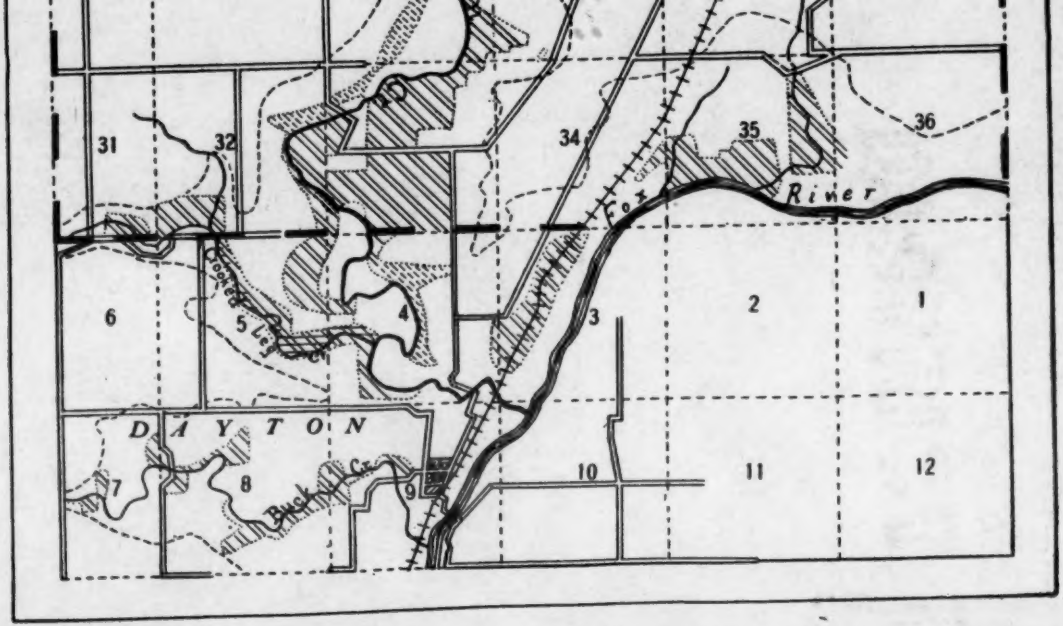
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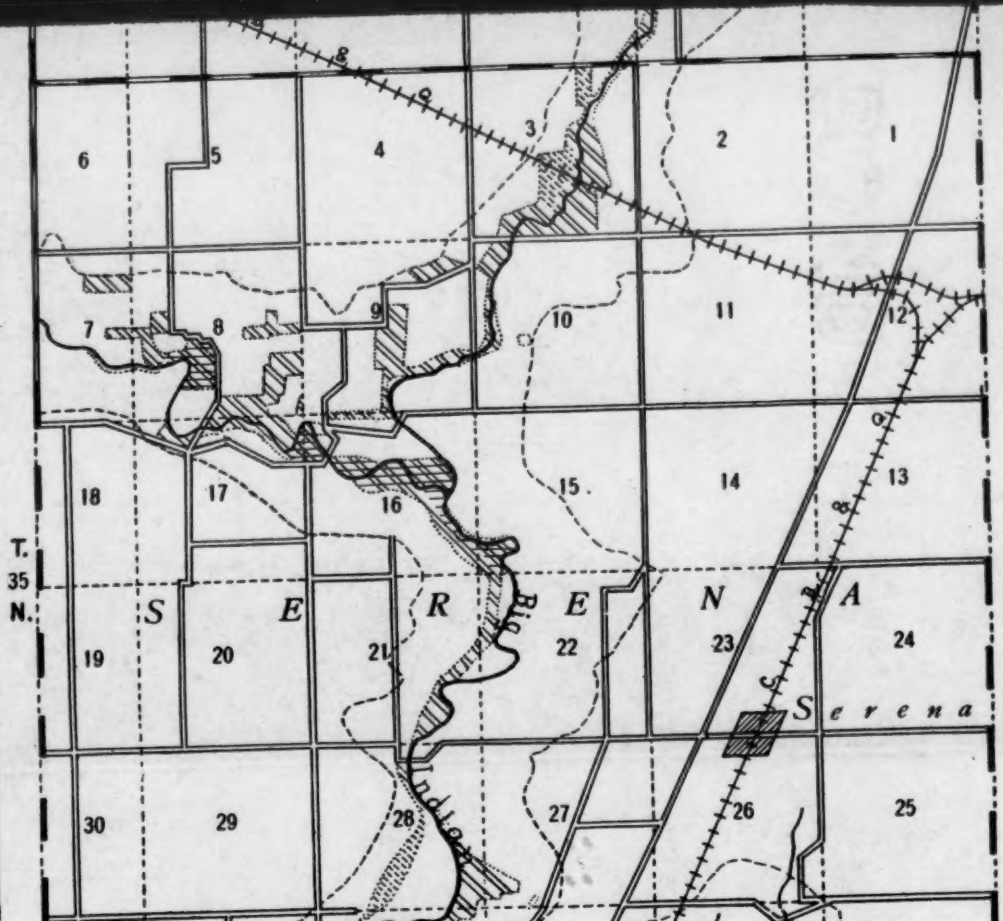
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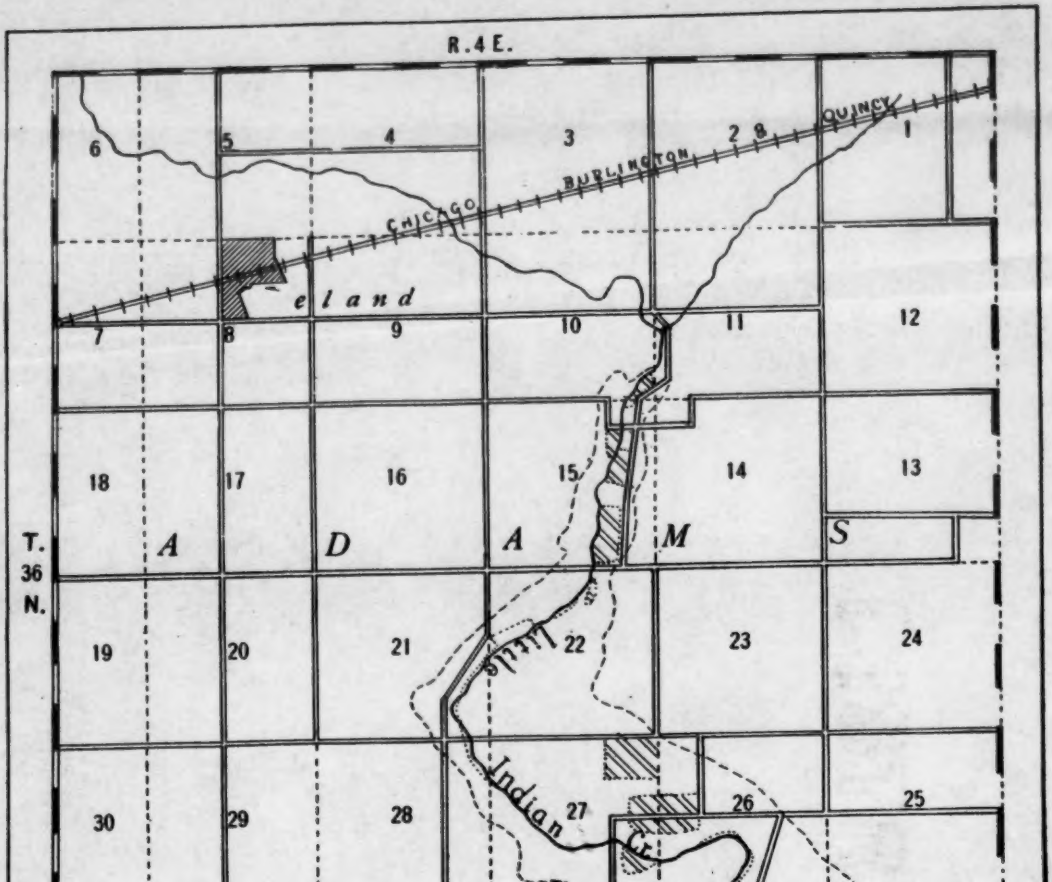
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UTICA
RIVER
DEER PARK
Oglesby
LA SALLE
PARK
VERMILION
C. R. I. and P. Ry.
C. B. and Q. R. R.
I. C. R. R.
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